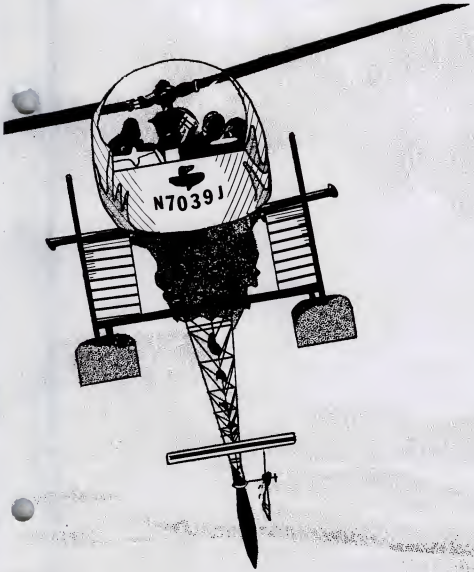

Montana Deer Studies

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Montana Dept. of Fish, Wildlife & Parks
Federal Aid Project W-120-R-11
Progress Report for Period
July 1, 1979 - June 30, 1980

Garbarino '80

JOB PROGRESS REPORT

RESEARCH PROJECT SEGMENT

STATE Montana

PROJECT W-120-R-11 NAME Statewide Wildlife Research

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INTRODUCTION

Deer, including mule deer and white-tailed deer, are the most common and widely distributed big game animals in Montana (Mussehl and Howell 1971). Widespread declines in mule deer populations in the state and throughout the West during the early 1970's generated much concern about reasons for the decline, the future of these populations and the direction of management efforts. Existing knowledge and methodology could not explain the problem or provide credible guidelines for either altering existing programs or developing new programs to more effectively manage the deer resource (Montana Chapter, TWS 1975, Workman and Low 1976).

Concurrent with the decline, evidence was accumulating that at least some concepts and methods commonly employed in deer management were either invalid or improperly applied or interpreted. Most of these were developed from studies conducted when deer populations were almost uniformly high. Many also were from short-term observations in a few areas or habitats, or from controlled experiments. All had limitations or carried assumptions that were only rarely considered or evaluated when applied to other areas or habitats, under varying environmental conditions, or to natural populations. Thus, for example, evaluations by Mackie (1973, 1976) indicated that range surveys, which provided a primary information base for deer management for many years, had only limited utility and could be misleading. Similarly, detailed literature reviews indicated that the effects of nearly all "limiting factors" on deer populations were only poorly documented and understood (Workman and Low 1976). Specific findings frequently were confusing or contradictory. This usually results from a paucity of long-term population perspective and the lack of concurrent information on all limiting factors (Lack 1954).

Because of these problems, a statewide deer research program was initiated in Montana in 1975-76. Broadly, the objectives of this program were to:

1. Provide a more detailed understanding of the population biology and habitat relationships of deer and of the factors limiting deer numbers in the diverse environments in which deer occur in Montana;

2. Develop new or improved methods for measuring deer population and habitat parameters, new guidelines for applying existing information and technology more effectively, and/or new criteria for interpreting field data in terms of management needs; and

3. Establish new guidelines for consideration of the habitat requirements and relationships of deer in other game, range, forest, and land management programs and practices in Montana.

The approach entailed concurrent, comparative investigations on the population ecology and habitat relationships of mule and white-tailed deer over several years in all of the major ecological or "habitat" types on which the two species occur. The rationale was that such studies provide the best opportunity to determine the normal range of population characteristics and behavior in natural populations and the relative importance of various "limiting" factors in population regulation over a wide range of habitat and environmental conditions. Thus, they should also provide the framework for understanding the process(es) of regulation in deer populations generally as well as the roles and importance of both intrinsic and extrinsic factors. At the same time, such studies would fill gaps in our knowledge of the behavior, specific habitat requirements and population characteristics of both species in all of the diverse habitats available and/or the full range of environmental conditions that prevail in those habitats.

Because of this, the study was designed to include both descriptive and evaluative research. The former to provide essential baseline data and information, to clarify existing knowledge, and to develop hypotheses concerning the environmental requirements and relations of deer and the processes by which population regulation occurs. The evaluative aspect was to examine existing management concepts, criteria and techniques, as well as to test new hypotheses formulated in the course of descriptive studies.

The initial study plan called for complete investigations, conducted by combinations of fulltime research staff, graduate student assistance and management personnel. Studies involving mule deer were to include the coniferous forest habitat in the northern Rocky Mountains of extreme western and northwestern Montana, the mountain-foothill habitats of central and southwestern Montana, the "breaks" and rough-upland habitats of central and eastern Montana, and the prairie-plains type of eastern Montana. For white-tailed deer, habitats included the coniferous forest of northwestern Montana, the mountain-foothill complex of central Montana, floodplains or bottomlands of major streams in central and eastern Montana, and prairie-agricultural lands of eastern Montana.

Limitations on funding and personnel, logistical considerations, and other coincident research needs precluded complete efforts in all areas or types during the first 5-year segment. Therefore, emphasis was directed to those areas in which problems or research needs and/or the opportunity to achieve basic study objectives were greatest. In the case of mule deer, these included the mountain-foothill habitat for which considerable background information was available, the "breaks" type in northcentral Montana on which mule deer population studies of a general nature had been conducted previously for 15 years, and the open plains-prairie type of eastern Montana. Each of these types contributed importantly to the total mule deer population and harvest in Montana, and, at the same time, provided excellent opportunity for population ecology studies.

Studies on whitetails were restricted to the coniferous forest habitat of northwestern Montana, where some prior information was available and current land use and timber harvest management practices posed a high, potential threat to whitetail populations. Some less intensive studies were conducted on the major river bottom type along the Missouri River in north-central Montana where some previous information was available, and on prairie-agricultural lands in extreme eastern Montana. In both areas, efforts were limited and in conjunction with mule deer studies in the general area.

Current deer study areas are located on the accompanying map of Montana (Fig. A). Solid circles denote deer research study areas from which findings are included in this report. Open circles denote management and other special study locations. Those inscribed with a T are management studies involving only deer population trend and classification measurements to date, though more intensive effort may be planned. Completely open circles denote studies which may also involve tagging and marking, or monitoring radio-collared deer, food and range use habits, and/or other habitat relations. Circles inscribed with an X denote special studies conducted by the Ecological Services Division of the Fish and Game Department and other agencies. The latter include the Decker Deer Study conducted by the U. S. Fish and Wildlife Service and deer studies in Glacier National Park.

Findings from management surveys and investigations are reported independently in Montana Department of Fish and Game Regional Progress Reports under project W-130-R and as other special progress reports from the Ecological Services Division or the Agency concerned.

This report compiles individual study and job progress reports for investigations conducted on or directly in conjunction with the intensive study areas during 1979-80. Individual study reports outline specific job objectives and procedures and present and discuss current findings in relation to information obtained previously as well as through supplementary thesis research projects associated with them.

Several separate publications and reports presented findings or other information resulting from the Statewide Deer Study. These include:

Hamlin, K. L. 1977. Population dynamics and habitat relationships of mule deer in the Bridger Mountains, Montana, 1955-76. Ann. Conf. N.W. Section, TWS, Kalispell, MT., Feb. 1977.

_____. 1978. Deer, coyote and alternate prey relations in the Missouri River Breaks Montana. Ann. Conf. N.W. Section, TWS, Portland, OR., Feb. 1979.

_____, and L. Schweitzer. 1979. Observations of coyote pairs attacking mule deer fawns. J. Mamm. 78(4).

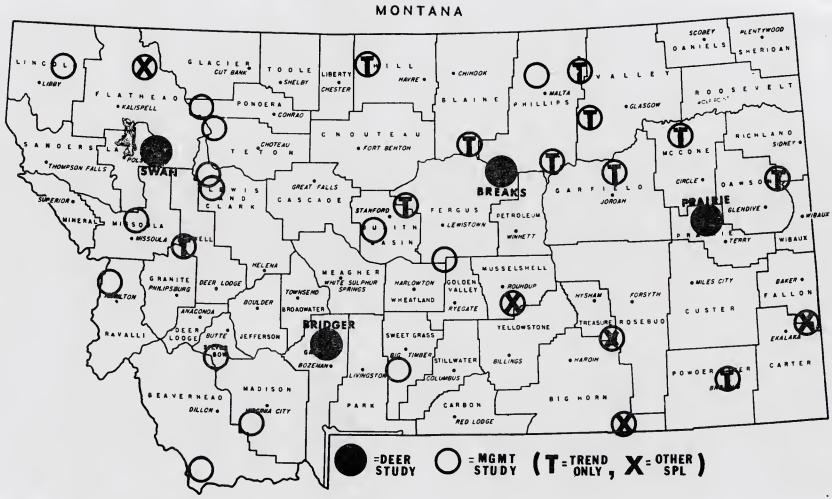

Figure A. Current deer studies in Montana.

Mackie, R. J. 1976. Interspecific competition between mule deer, other game animals and livestock. Pages 49-54 In mule deer decline in the west. A Symposium. Utah State Univ. Coll. of Nat. Resour., Agr. Exp. Sta., Logan.

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_____, and D. F. Pac, 1980. Deer and subdivisions in the Bridger Mountains, Montana. Proceed. West Assoc. of State Fish and Wildlife Agencies. Kalispell, MT. June 1980. *(in press).*

Mundinger, J. G. 1979. The Swan Valley: whitetail country, Mont. Outdoors 10(5): 35-41.

_____. *In press.* Reproductive biology of white-tailed deer in the Swan Valley, Montana. J. Wildl. Manage.

While all of the studies described are still in progress, and thus many findings are only preliminary, results to date have provided much new information on the general biology and ecology of deer. Included are a much better and more detailed understanding of distributional characteristics and patterns and their significance in the ecology of natural populations. Also included is a better knowledge of reproductive characteristics and relationships in natural populations as well as the roles of fawn production and survival, population sex and age structure, and mortality patterns of both fawns and adults of both sexes as they influence population size and dynamics annually and in various habitats.

Tentative conclusions from these findings together with their management implications are discussed in an addendum to this report. Deer management recommendations also are discussed.

The studies reported in this document required the efforts of numerous individuals, both with the Montana Department of Fish, Wildlife and Parks and in other agencies. The cooperation of personnel of the U. S. Forest Service, Bureau of Land Management and the U. S. Fish and Wildlife Service, C. M. Russell Wildlife Range, has been especially appreciated. Without their combined interest and effort this study would not be possible. Gratitude is also expressed to numerous private individuals who have, as landowners, provided access to their lands and study areas or otherwise provided assistance in the investigations.

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Lack, D. 1954. Natural regulation of animal numbers. Oxford Univ. Press. 343pp.

Mackie, R. J. 1973. Responses of four browse species to protection on big game ranges in western Montana. Job Compl. Rept., Fed. Aid Proj. W-120-R-3, Montana Dept. Fish and Game. 30pp.

_____. 1976. Effectiveness of the key browse survey method. Job Prog. Rept., Fed. Aid Proj. W-120-R-6, Job BG-2.01. 20pp. (multilith)

Mussehl, T. W. and F. W. Howell (eds.). 1971. Game Management in Montana. Montana Dept. Fish and Game booklet. 238pp.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana.

ABSTRACT:

Studies to evaluate factors affecting populations of white-tailed deer (*Odocoileus virginiana*) in the Swan River Valley, Montana were continued during 1979-80. Data were collected at two checking stations during the 1979 hunting season. Distribution of hunting pressure and harvest is discussed. Weights and body measurements of hunter-killed deer indicated growth patterns. Two methods for estimating age were compared. The winter range was a diverse community, occupied by a mature, sub-climax forest. Fire apparently perpetuated that condition. Winter observations of deer typically occurred in mixed timber stands, dominated by Douglas fir, western larch, and lodgepole pine. Several habitat types were represented. Use of natural openings and clearcuts was minor. Telemetry equipped animals provided additional information on winter range use. Definitive winter home ranges of those animals were less than 160 acres. Each home range included a small activity center. Timbered riparian and timbered upland habitats were integral components of individual home ranges. Winter food habits are discussed. Population parameters were determined from a harvest sample of 195 deer, a road-kill sample of 30 deer, and observations of 3,949 deer. Fawns comprised approximately 30% of the 1980 winter population. Reproductive tracts have been collected from 142 does. No pregnant fawns were examined. Fetal and ovulation rates for all adult does were 1.5 and 1.7, respectively. The reproductive success of 70 marked adult females was determined during 1980. Survival was estimated by three independant methods. A rate of approximately 70% for all animals was determined. That value was consistent with the recruitment rate, thus suggesting a stable population. Patterns of summer dispersal were determined from telemetry data and hunter tag returns. Summering areas of individual deer were typified by interspersion of mature coniferous timber with natural openings and wet sites. Recommendations which concern timber management, deer management, and future research are presented.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana.

JOB OBJECTIVE: To determine the environmental requirements of white-tailed deer and factors regulating white-tailed deer populations in the coniferous forest habitat of northwestern Montana.

To determine the effects of various potentially competing land use and management practices upon white-tailed deer in northwestern Montana.

To develop new and improved guidelines for management of northwestern Montana white-tail populations and their habitats.

INTRODUCTION

The white-tailed deer (*Odocoileus virginiana*) is the most abundant, widely distributed, and important big game species in northwestern Montana. There its distribution is closely associated with the coniferous forest. Recent trends have indicated reduced white-tailed deer harvests and increased hunting pressure. Concurrently, large areas of deer habitat have been developed for other values, particularly timber production and sub-divisions.

A study to evaluate factors affecting white-tailed deer in the Swan Valley was initiated in November, 1975 as one phase of the Montana Statewide Deer Research. This area was selected because it traditionally has been an important deer range and it is representative of a major ecological type in which white-tailed deer occur. The study has emphasized the collection of information basic to distribution, movements, habitat use, and population dynamics.

STUDY AREA

The upper Swan River Valley extends from Swan Lake south, approximately 40 miles, to the Swan-Clearwater Divide (Fig. 1). The valley lies between the Swan Range to the east and the Mission Mountains to the west and ranges from 6 to 10 miles in breadth. The valley is bisected by the Swan River and by Highway 83 which parallels the river. Elevations range from 2900 to 4600 ft. on the valley floor and from 6800 to 10,200 ft. in the bordering mountains. The primary winter range in the upper Swan Valley lies between Goat Creek and Condon. Condon is approximately 65 mi. southeast of Kalispell.

Logging had a minor impact in the Swan Valley prior to 1955. Since then, timber harvest has occurred in approximately 30 percent of the area. Approximately 45 percent of the winter range has been clear-cut in units of from 5 to 160 acres. The extent of logging has varied on summer range; certain areas have not been logged, while others have been harvested in units which range from 5 to greater than 640 acres.

Additional description of the Swan Valley was presented by Hildebrand (1971) and Antos (1977). The history of game population in the Swan Valley and

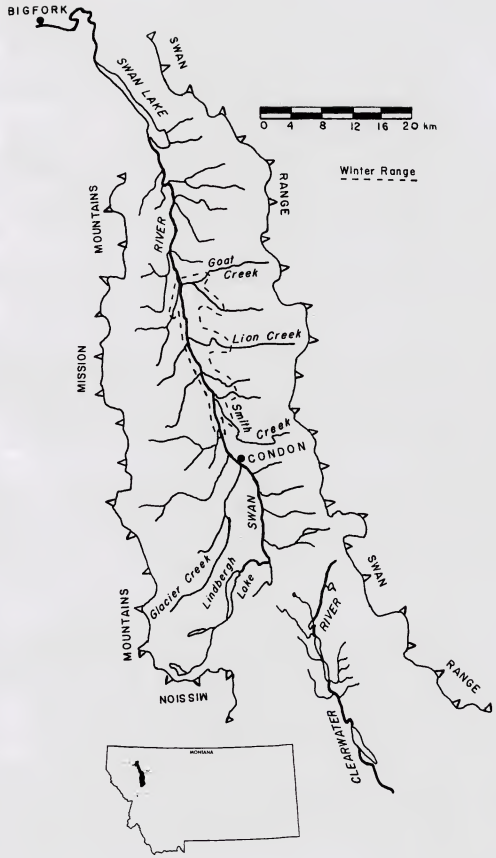


Figure 1. Map of study area.

summaries of the early studies are included in Weckwerth (1958), Hildebrand (1971), and Mundinger (1976).

Winter extends from mid-November through March. Snow cover generally is continuous during that period. Thaws and cool rain are typical during January and February. A mild winter occurred during 1975-76. Winter severity indices (WSI)(Picton and Knight 1969), for the period 15 November-31 March, were calculated for 1976-79 from the Swan Lake Weather Station data. An index for 1979-80 will be calculated when the data becomes available. The 1976-77 winter was unusually mild (WSI = 2,100). Three major snowstorms occurred and snow persisted from 25 November through 9 April. Yet, snow accumulations never were heavy and portions of the winter range frequently were bare. One thaw occurred during January and daily maximum temperatures were above freezing throughout February and March. The 1977-78 winter was normal (WSI = 12,445). That year eight major snowstorms occurred and snow persisted from 17 November through 8 April. Snow accumulations were heavy from late December through mid-March. Temperatures were normal. A severe winter occurred in 1978-79 (WSI = 26,457). Eight major snowstorms occurred and the snow cover persisted from 13 November through 15 April. Snow accumulations were heavy through mid-March. Temperatures were unusually cold throughout December and January, and first thaw did not occur until early February. Thereafter, temperatures were normal. The 1979-80 winter was difficult to categorize. Snowfall was below normal and, although snow accumulations never were heavy, snow persisted from mid-November through late April. Early winter temperatures were normal or warmer; late winter-early spring temperatures were below average. Thus, the winter was mild, but extended later into April.

METHODS

Hunting Season

Two part-time checking stations were operated on various schedules. Hunters were interviewed to determine hunter origin, drainages hunted, time hunted, and animals observed. Locations of animals harvested were plotted on a map. Ages of white-tailed deer, mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) were determined by criteria of eruption and wear of teeth in the lower jaw (Severinghaus 1949; Robinette et al. 1957; Quimby and Gaab 1957). First incisors were collected from adult white-tailed deer for analysis of annuli in the cementum layer (Gilbert 1966). Weights and body measurements of white-tailed deer also were collected. Additional harvest data were compiled for Hunting Districts 130 and 131 from the Montana big game hunter questionnaire.

Trapping

A total of 411 white-tailed deer were captured, marked for individual recognition, and released during the four winters, 1976-79. Of those, 39 were equipped with telemetry transmitters. Most animals were captured with Clover Traps (Clover 1954). Oregon-style traps (Lightfoot and Maw 1963) and a cannon-net (Hawkins et al. 1968) also were employed during 1976.

Production

Information concerning recruitment was determined from winter classifications of white-tailed deer. That was supplemented with classifications of animals in

the harvest, trapping, and highway mortality samples.

When collared does were observed, I attempted to determine if they had fawns. Repeated observations substantiated many doe-fawn associations. Questionable observations were not included in the analysis.

Pregnancy, fetal and ovulation rates were determined from autopsies of highway mortalities and trap causalties. Those data were compiled according to the age-class of the doe.

Survival

Sex and age specific survival rates were estimated from the numbers of known survivors among the collared deer. Those estimates were verified with survival estimates determined from the harvest age-structure (Eberhardt 1969) and with computer population simulation (Mooney and Lonner 1978).

Trend Routes

A 16.6 mi. trend route, extending from the State Forest Headquarters at Goat Creek to the Condon Ranger Station was established. That route was traveled in a vehicle at 15-20 mph and all observed animals were tallied. I tried to conduct these surveys at two-week intervals from early January through early April, 1977 - 1980, although it was not always possible to maintain that schedule. Surveys began at approximately 15 minutes before sunrise. Surveys were not conducted on days with extreme weather conditions, either stormy or bright, clear days.

Condition

Dead animals were examined to determine their condition at the time of death. General descriptions of the subcutaneous, visceral, and femoral fat deposits were made. Condition was quantified with a kidney fat index (Riney 1955) during 1976-77, and with an assay of the femur marrow fat (Verme and Holland 1973) during 1978-80.

Food Habits

Food habits were determined by rumen analysis. Rumen contents were examined according to Wilkins (1957). Analysis followed the aggregate percentage method (Martin et al. 1946).

Distribution and Movements

All observations of deer were plotted according to the legal description of the location. A general description of the surrounding habitat also was made. Additional information resulted from observations of collared animals and relocation of telemetry equipped deer.

Migratory patterns were determined by radio telemetry, supplemented with tag-returns of hunter-killed deer. Few animals with observation collars were seen during summer, and most of those could not be correctly identified.

During summer, radio-equipped deer frequently were relocated from a fixed-wing aircraft. That information was supplemented with ground relocations. Summer range use was determined from reconnaissance of the areas used by those individuals.

RESULTS AND DISCUSSION

Hunting Season

Five-week hunting seasons occurred in the Swan Valley during this study. The 1975 season included 3 weeks of either-sex hunting and 2 weeks during which only bucks were legal. The 1976-79 seasons employed a format of 8 days of either-sex and 4 weeks of males only hunting.

Hunting season parameters, as determined from the big game questionnaire and the lower Swan Check Station, are presented for the five hunting seasons in Table 1. The lower Swan station was open on weekends in 1975. During 1976-79 the station was open daily during the either-sex portion of the season and on weekends thereafter. The format of the questionnaire was changed in 1978. Also, Hunting District 131 was incorporated into Hunting District 130 that year.

Table 1. Summary of 1975-79 hunting seasons in the Swan Valley.

	1975	1976	1977	1978	1979
Season Format					
Either-Sex	10/19-11/9	10/24-10/31	10/23-10/30	10/22-10/29	10/21-10/28
Males Only	11/10-11/23	11/1-11/28	10/31-11/27	10/30-11/26	10/29-11/25
Hunter Days					
Questionnaire	40,511	33,606	39,691	31,653	30,914
Check Station	2,750	3,317	3,239	3,016	2,640
White-tail Deer Harvest					
Questionnaire	635	523	736	625	612
Check Station	98	104	154	124	150
Mule Deer Harvest					
Questionnaire	70	94	86	69	96
Check Station	13	15	24	12	12
Elk Harvest					
Questionnaire	293	125	222	135	123
Check Station	51	29	39	29	29
White-tail, % adult males					
Questionnaire	55	74	79	79	67
Check Station	49	66	68	66	41
Deer Hunters (Questionnaire)	4,501	3,673	4,323	3,779	3,647
% Deer Hunter Success (Questionnaire)	17	17	20	18	20

The questionnaire and checking station data indicated comparable trends in the harvests of white-tailed deer, and the indicated rates of change were similar between 1976 and 1978. Trends in mule deer and elk harvests were difficult to interpret from these data because the samples were small.

The questionnaires indicated greater hunting pressure during 1975 and 1977, years in which greater numbers of elk were harvested. That trend was not evident in the checking station data. The questionnaire also suggested that variation in the total hunting pressure resulted from variation in the number of elk hunting trips moreso than in the number of deer hunting trips. Elk and deer hunters were not distinguished at the checking station.

The Swan Divide Check Station (Table 2) was operated on weekends during 1977-79. That station also was open daily during the 1977 either-sex season.

Table 2. Swan Divide checking station summary.

	Year		
	1977	1978	1979
Hunters	901	668	865
White-tail deer harvest	52	21	45
Mule Deer Harvest	3	3	4
Elk Harvest	16	3	6

The majority of hunters checked at both stations were local residents. In all years, residents of Flathead, Lake and Missoula Counties comprised more than 90 percent of the hunters.

A total of 33 marked white-tailed deer was harvested and reported during the 1976-79 seasons. Two other dead deer with collars were found and reported by hunters during the 1979 season. These were does that had either been crippled or illegally shot and left. Population estimates (Overton and Davis 1969), derived from numbers of tag returns, minimum numbers of tagged animals known to be alive, and the harvest data, were attempted. These were unreliable because the number of tag returns was small, tagged animals may not have been reported, the number of tagged animals was small in relation to the total population, and the tagged animals were not uniformly distributed throughout the population. However, tag returns did indicate that only a small percentage of the population was harvested each year. Tag returns represented between 5 and 11 percent of the number of marked animals that were known to be in the population during each hunting season.

The distribution of hunting pressure, as determined from interviews at the lower Swan checking station, was similar each year (Table 3). Approximately half of the hunting pressure occurred between North Lost Creek and Dog Creek in the east side of the valley, approximately one-fourth of the area checked.

Table 3. Percent distribution of hunting pressure and harvest, as determined from the lower Swan checking station interviews during 1975-79 hunting seasons.

Drainage	Hunting Parties				W-T Deer				Mule Deer				Elk			
	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
Bear Creek-Johnson Creek	7	3	4	4	5	3	3	3								
6 Mile Creek-Bond Creek	4	4	4	6	3	5	3	5		4			3	3		
West Swan Lake	8	11	12	12	5	9	7	8	13	29	8	8	3	8	24	7
N. Lost Cr. & S. Lost Cr.	10	12	9	8	7	3	7	3	27	17	8	17	9	14	14	14
Cilly Creek-Soup Creek	16	16	18	13	5	7	5	3		4			6	14	10	11
Squaw Creek-Van Lake	19	15	12	15	13	13	13	12	7			17	31	10		25
Lion Creek-Dog Creek	8	10	12	9	8	13	15	9	27	17	25	8		36	21	36
Condon Creek-Smith Creek	6	4	4	5	18	7	10	13	13		8	8			21	4
Cooney Creek-Owl Creek	4	5	5	4	10	7	9	11	7		8		6		7	
Subtotal H.D. 130	82	81	80	77	73	67	72	68	93	71	58	58	59	86	97	96
Woodward Creek-Fatty Creek	4	5	6	7	1	5	4	10	7	17	17	25	19	3		
Piper Creek-Cold Creek	9	9	8	11	10	11	9	12		8	8	17	9	3		
Elk Creek-Kraft Creek	4	5	5	4	12	14	14	8		4	17		9	8	3	4
Lindbergh Lake-Beaver Creek	1	1	1	1	4	3	2	2					3			
Subtotal H.D. 131	18	19	20	23	27	33	28	32	7	29	42	42	41	14	3	4
SAMPLE SIZE	1,496	1,572	1,508	1,395	101	151	123	148	15	24	12	12	32	36	29	28

During each year, a disproportionately higher percentage of the white-tailed deer harvest, relative to hunting pressure, was taken south of Condon Creek on the east side and south of Elk Creek on the west side of the valley. The highest summer densities of deer probably occurred in those drainages, but hunters did not respond to that availability.

The distribution of hunting pressure and harvest, as determined from the Swan Divide station, is presented in Table 4. The most noteworthy trend was a decline in hunting pressure and harvest with increasing distance north from the Swan-Clearwater Divide.

Several differences in the white-tailed deer harvest distribution, since 1959, were indicated (Table 5). The most notable were a reduction in the proportion of the harvest taken between Squaw Creek and Dog Creek, an average of 47% prior to 1959 as compared with an average of 23% during 1975-79; an increase in the proportion of the harvest taken from south of Condon, an average of 22% prior to 1959 as compared with an average of 46% during this study; and, a broader distribution of the harvest. Those differences resulted from an increased road density throughout the Swan Valley and a probable decline in the density of deer which summers on or near the winter range.

Weights and Measurements

Hog-dressed weights and body measurements were collected at the check station. Body measurements included total length, from the tip of the nose to the base of the tail; height at the shoulder; and, length of the hind foot. Data for the five hunting seasons were pooled (Table 6).

The body size of females increased significantly ($p < 0.05$) through $2\frac{1}{2}$-years and weight increased significantly through $3\frac{1}{2}$-years. The average total length of $4\frac{1}{2}$-year-old females was significantly greater than that of $2\frac{1}{2}$-year-old females, although no statistical differences ($p > 0.05$) between $2\frac{1}{2}$-and $3\frac{1}{2}$-year-olds and $3\frac{1}{2}$-and $4\frac{1}{2}$-year-olds were detected. These data indicated that females did not attain physical maturity until $3\frac{1}{2}$-years. It is probable that growth continued beyond that age. However, sample sizes of older age-classes were small and variances within those samples were large. Therefore, statistical tests were not sensitive to growth beyond $3\frac{1}{2}$-years.

The body size and weight of males increased significantly ($p < 0.05$) through $5\frac{1}{2}$-years. Large variation in size and weight occurred within individual age-classes. Because this was apparent in the youngest age-classes, it suggested differences in individual growth potential.

Hog-dressed weights of Swan Valley white-tailed deer were heavier than average weights for the species in Montana (Mackie 1964). They also were heavier than those reported for the Fisher River-Wolf Creek area in northwest Montana (Firebaugh et al. 1975). Weights and body measurements were similar to those reported for white-tailed deer in the Clearwater drainage (Janke 1977).

Age Data

The age distributions of the 1975-79 white-tailed deer harvests are presented in Table 7. Animals were assigned to fawn, yearling, and $2\frac{1}{2}$-year-old classes according to criteria of eruption-wear (Severinghaus 1949). Older deer were

Table 4. Percent distribution of hunting pressure and harvest as determined from the Swan Divide checking station interviews during the 1977-79 hunting seasons.

Drainage	Hunting Parties			W-T Deer			Mule Deer			Elk		
	1977	1978	1979	1977	1978	1979	1977	1978	1979	1977	1978	1979
Bear Creek-Johnson Creek												
6 Mile Creek-Bond Creek												
West Swan Lake	1			2								
North & South Lost Creeks	1	1		4	5					7		
Cilly Creek-Soup Creek	1	1										
Squaw Creek-Van Lake	2	1	1				33					17
Lion Creek-Dog Creek	5	7	4	6	10	9			25			17
Condon Creek-Smith Creek	9	6	4	8	14	4	33					17
Cooney Creek-Owl Creek	34	23	28	40	10	24	33	100	25	53	33	33
H.D. 130	53	39	37	60	38	38	100	100	50	60	33	83
Woodward Creek-Fatty Creek	1	1				2						
Piper Creek-Cold Creek	6	6	8	4		2				7		17
Elk Creek-Kraft Creek	18	19	18	23	38	18					33	
Lindbergh Lake-Beaver Creek	23	35	37	13	24	40			50	33	33	
H.D. 131	47	61	63	40	62	62	0	0	50	40	67	17
Sample Size	396	292	359	52	21	45	3	1	4	15	3	6

Table 5. Comparison of the percentage distribution of the white-tailed deer harvest from checking station data, 1948-1979.

	1948[1]	1949[1]	1957[1]	1958[1]	1959[1]	1962[2]	1975[2]	1976[2]	1977[1]	1978[1]	1979[1]
Sample size	48	51	255	196	196	39	91	101	203	144	193
Drainage											
East Swan Lake	27	18	4	8	3	8	9	8	6	6	7
West Swan Lake				2	5	3	2	5	7	7	6
North and South Lost Creeks		4	6	5	1	8	7	7	3	6	3
Cilly Creek-Soup Creek	4	6	7	4	7	8	8	5	5	4	2
Squaw Creek-Van Lake	31	31	21	19	32	21	22	13	10	11	9
Lion Creek-Dog Creek	23	16	22	13	25	15	8	8	11	14	9
Condon Creek-Smith Creek	4	2	5	11	5	10	22	18	7	10	11
Cooney Creek-Owl Creek	8	10	18	14	9	13	6	10	16	9	14
Subtotal H.D. 130	98	86	82	76	87	85	82	73	65	67	61
Woodward Creek-Fatty Creek	2	12	5	6	9	3	4	1	4	3	8
Piper Creek-Cold Creek			4	8	1	3	9	10	9	8	10
Elk Creek-Kraft Creek		2	4	2	1	10	4	12	16	17	10
Lindbergh Lake-Beaver Creek			4	8	2			4	5	5	11
Subtotal H.D. 131	2	14	18	24	13	15	18	27	35	33	39

[1] Data summarized from two checking stations.

[2] Data summarized from lower Swan checking station only.

Table 6. Average hog-dressed weights and body measurements of white-tailed deer harvested in the Swan Valley, 1975-79.

Sex	Age	Weight (lbs.)	Length cm	Height cm	Hind foot cm	Sample size
Females	½	56.3	114.0	77.2	40.7	34
	1½	97.1*	134.3*	88.7*	45.6*	32
	2½	106.5*	140.7*	91.6*	46.6*	35
	3½	112.7*	143.5	92.1	46.8	14
	4½	116.4	145.6	91.5	46.8	11
	5½	121.0	132.5	100.0	46.0	1
	6½	114.0	143.5	91.6	47.1	4
	7½	109.3	135.2	92.3	46.3	2
	8½	121	144.2	91.5	46.8	6
	9+	115.6	145.9	95.8	46.8	5
Males	½	62.6	115.8	79.9	41.9	36
	1½	113.7*	141.2*	94.3*	47.8*	118
	2½	146.0*	150.6*	99.5*	49.5*	56
	3½	159.0*	158.4*	102.3*	49.8	26
	4½	175.8*	156.5	102.9	49.7	17
	5½	194.9*	166.6*	104.3	51.4*	10
	6½	187.4	163.1	104.2	49.5	8
	7½	186.4	163.9	104.7	50.2	7
	8½	186.7	164.1	100.4	50.6	4
	9+	178.3	161.1	105.1	49.6	4

* Significantly greater, $P < 0.05$, than preceding number in column.

assigned to age-classes according to an analysis of the dental cementum in the first incisor (Gilbert 1966). Four deer were assigned to the 3½-year-old class based on wear characteristics because the cementum analyses, which indicated ages of 2½-years, were presumed to be incorrect. In addition to the animals for which age was determined, 30, 7, 7, 9, and 18 unaged adult deer were checked during the five respective hunting seasons. The harvest age-structure is compared with that recorded in earlier years in Table 8.

Jaws were collected from adult white-tailed deer during the hunting seasons and from trap-casualties and highway mortalities. These permitted a comparison between eruption-wear and cementum analysis as methods for determining age of white-tailed deer (Table 9). That sample included 9 known-age animals. The ages of five 2½-year-olds were correctly determined by eruption-wear; one of these was incorrectly assigned to the yearling class by cementum analysis. The ages of two 3½-year-old deer were correctly determined by both methods. The age of one 4½-year-old and one 5½-year-old were correctly determined by cementum analysis; each had been assigned to the 3½-year-old class by wear characteristics.

Eruption-wear was assumed to be a reliable technique through 2½-years. Fawns and yearlings were accurately determined by the characteristic combination of deciduous and permanent dentition (Severinghaus 1949). Two-and-one-half-year-old

Table 7. Percent composition, by age-class, of the white-tailed deer harvest in the Swan Valley, 1975-79.

Age-Class	Females					Males					Total				
	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979
½	30	14	31	26	26	14	12	11	12	22	20	12	18	16	24
1½	13	57	17	31	16	33	39	46	45	41	25	43	37	41	30
2½	17	14	25	15	26	25	22	16	22	16	22	21	19	20	21
3½	9		5	10	14	8	4	11	9	8	8	3	9	10	11
4½	9	5	9		9		8	10	2	1	3	7	10	1	5
5½			2	5		8	3	1	5	3	5	2	1	5	2
6½	9	5	3	3	3		4	3		4	3	4	3	1	3
7½	9			5		6	3		2	2	7	2		3	1
8½		5	3	5	1	6	4			1	3	4	1	1	1
9½							1		1			1		1	
10½			3					1		1			2		1
11½					1				1					1	1
12½					1										1
13½	4										2				
14½			2		3								1		1
Sample size	23	21	64	39	77	36	76	135	97	98	59	97	199	136	175

Table 8 . Percent composition, by age-class, of the white-tailed deer harvest from the Swan River Valley, 1951-1979.

Year	Age-Class 1½	1½	2½	3½	4+	Sample Size
1951	19	31	22	16	12	170
1953	10	33	24	5	29	21
1957	30	14	14	17	25	164
1958	18	47	6	12	17	68
1959	21	18	16	7	38	57
1962	23	36	14	9	18	22
1969	31	26	14	15	14	78
1975	20	25	22	8	25	59
1976	12	43	21	3	21	97
1977	18	37	19	9	17	199
1978	16	41	20	10	13	136
1979	24	30	21	11	14	175

Table 9. Comparison of age determinations by tooth eruption and wear with age determinations by dental cementum.

Assigned age by dental cementum	Assigned age by tooth eruption and wear 2½	3½	4½	5½	6½	7½	8½	10½	Sample size
1½	2								2
2½	90	4							94
3½	5	40							45
4½		23	5						28
5½		6	5	3	1				15
6½		2	6	8	2				18
7½			5	4		1			10
8½			5	5	2				12
9½				1			1		2
10½				2	1	1	1		5
11½						1	2		3
12½					1	1	1		3
13½						1			1
14½						1		2	3

deer had permanent dentition and the lack of wear and staining, especially on the premolars, was very distinctive. Ages of older deer, as determined by wear characteristics, consistently were younger than those indicated by cementum analysis (Table 9). Deer from the Swan Valley apparently do not develop dental wear patterns as rapidly as those described by Severinghaus (1949). The differences between the two methods would not have been as great had a representative sample of known-age jaws from the Swan Valley been available for comparison with the present jaw sample. The jaw board (Quimby and Gaab 1957) used during this study contained jaws collected in the Swan Valley and assigned to age by Severinghaus' (1949) descriptions.

Cementum analysis probably was the more reliable technique for older animals but that method was not always correct. The ages of 11 of 141 animals in the 2½- and 3½-year-old classes were incorrectly determined by cementum analysis (Table 9). That suggested that errors also occurred in the older age-classes, but the frequency of those errors could not be determined. Few examples of tooth sections, in which each annulation was determined with certainty, were encountered. Typically, annuli were incomplete in portions fo the section and compressed in other portions. That count with the best agreement between two sections from the same tooth was, therefore, assumed to be indicative of the age of the animal.

Winter distribution and range use

The upper Swan Valley white-tailed deer winter range extends from Goat Creek south approximately 12 miles to Condon Creek, and from the western flood plain of the Swan River east approximately 1.5 miles. From that boundary, narrow extensions occur westerly into Woodward, Cedar, and Cold Creeks, easterly into Squeezer, Lion, Pony, Dog, Condon, and Smith Creeks, and southerly, along the river, to Condon. Isolated wintering areas, associated either with the Swan River or its tributaties, also occur south of Condon.

The winter range is a mature sub-climax forest and six dominant habitat types (H.T.) (Pfister et al. 1977) occur. The *Picea/Clintonia uniflora* H.T. occurs along the bottoms of the Swan River and its tributaries, and adjacent to potholes and marshes. This type is replaced by the *Thuja plicata/Clintonia uniflora* H.T. on certain moist sites, especially in Squeezer Creek. The *Pseudotsuga menziesii/Symphoricarpos albus* and *Pseudotsuga menziesii/Calamagrostis rubescens* H.T.s occur on warm, dry upland sites. The *Abies grandis/Clintonia uniflora* and *Abies lasiocarpa/Clintonia uniflora* H.T.s occur on cool, moist upland sites.

Forested uplands are mixed communities. Douglas fir (*Pseudotsuga menziesii*) in various combinations with western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and ponderosa pine (*Pinus ponderosa*) dominate. These species are important components of seral communities within the major upland habitat types. Grand fir (*Abies grandis*) and sub-alpine fir (*Abies lasiocarpa*) are the indicated climax on certain upland sites, but they are poorly represented. Spruce (*Picea* spp.) or western red cedar (*Thuja plicata*) dominate mixed communities on mesic sites.

The upland topography is an interspersion of ridges, knobs, benches, and draws. Therefore, distinguishable areas of uniform habitat type generally were small. Ecotones, in which more than one climax was indicated in the overstory, understory, or both, frequently occurred. Larger areas of otherwise

uniform habitat type contained many small inclusions. Cover type and habitat type boundaries often did not coincide. Stands of uniform habitat type included more than one cover type; or more frequently, stands of uniform cover type included two or more habitat types.

The winter range contained central mesic areas; the adjacent riparian zone was ecotonal; and, the associated upland was a timbered mosaic. This was a diverse habitat. Interspersion characterized the riparian and upland communities and the relationship between these communities.

Distinct deer concentrations occurred in proximity to mesic areas. This was evidenced by frequent observations of deer in riparian habitat. Heavily used trails occurred in such areas and these trails followed obvious topographic features. For example, two major trails were parallel to and east of the Swan River through the length of the winter range. They occurred in the flood-plain, near the river, and at the edge between riparian and upland habitats. Frequent bed sites, normally in the snow-wells of large trees, were encountered near these trails.

Deer consistently used the timbered uplands but that use was dispersed. Secondary trails, which originated from major trails in riparian areas, occurred throughout the uplands. Minor trails and tracks of individuals radiated from the secondary trails.

Coniferous cover was an integral component of upland habitat. Use of clear-cuts and natural openings was minor in all winters except 1977. During that mild winter, deer used clearcuts peripheral to the normal winter distribution (Mundinger 1977). In other winters, use of large openings was restricted either to the margins or to a single trail, with no radiating trails or tracks, that crossed the opening.

Radio-collared does moved to the winter range during late November - mid-January. Two types of movements were observed. Animals either moved directly to their respective wintering areas, or they moved to an intermediate area within or peripheral to the winter range, and from thence to their respective wintering areas. Additional movements within wintering areas also were observed. These appeared to be gradual reductions in the individual's cruising radius, such that individuals occupied definitive home ranges, or areas of most confinement, only in late winter-early spring. Two radio-collared does occupied the winter range yearlong, but their respecitve seasonal ranges did not coincide.

Ten radio-collared does were followed during three consecutive winters. Two of these, #26-78 and #63-78, used similar home ranges each year, 1978-80, in Cedar Creek and Pony Creek, respectively.

Deer #27-76 and #36-76 (Fig. 2), occupied intermediate areas within the winter range throughout the 1976 and 1977 winters. In 1978 they both occupied the respective intermediate ranges during early winter, moved to definitive home ranges in mid-winter, and returned to the intermediate ranges prior to departing for the summer.

Deer #60-76 used an intermediate range, peripheral to the winter range, in late fall-early winter and again each spring. She occupied the same winter area each year (Fig. 3). In 1977 she used the entire 280 acres. When con-fined, whe used 148 acres of that area in 1976, and 119 acres in 1978.

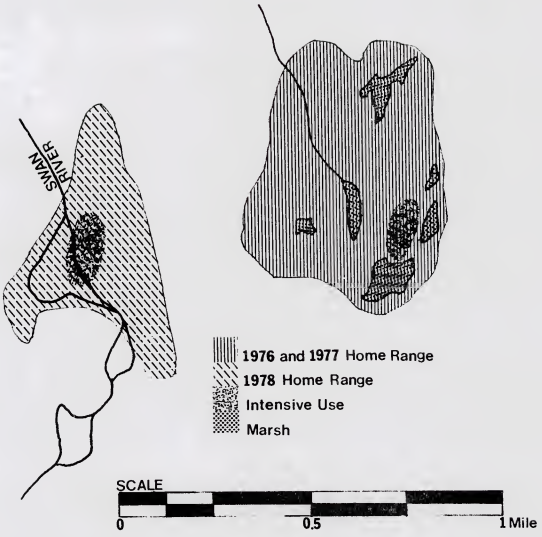


Figure 2. Winter home range of deer 36-76.

Deer #4-76 did not use an intermediate range and occupied the same winter area each year (Fig. 4). She used the entire 230 acres in 1977. That area included two different confinement areas, 156 and 47 acres, which were used in 1976 and 1978, respectively.

Deer #25-77 occupied a 115 acre winter home range during 1977 (Fig. 5). Subsequently, I never found her in that area. In 1978 and 1979 she occupied a 95 acre area that was near, but distinct from her 1977 winter home range. Her summer range was less than 3 miles down-river from her definitive winter range. In 1978 and 1979 her return movements were gradual.

Deer #41-78 wintered near the confluence of Goat and Squeezer Creeks in 1978-80 and used a similar area each year (Fig. 6). She used an intermediate area along Goat Creek each spring. In the fall she first returned to that intermediate area, then gradually moved down Goat Creek and occupied her definitive winter range by mid-February.

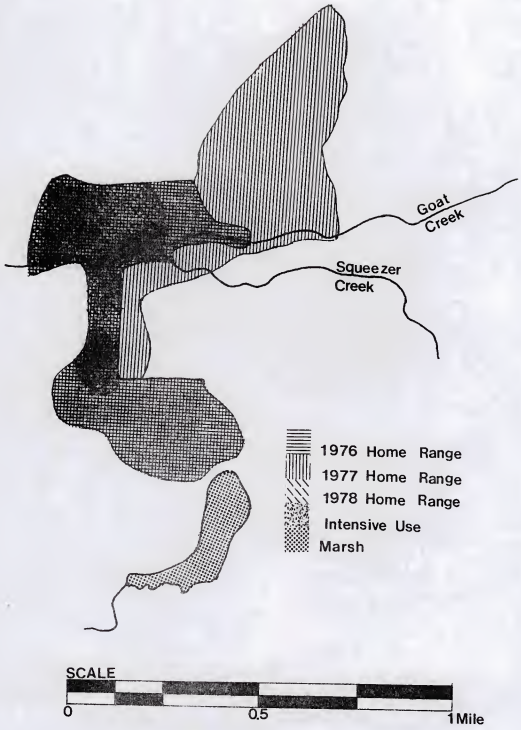
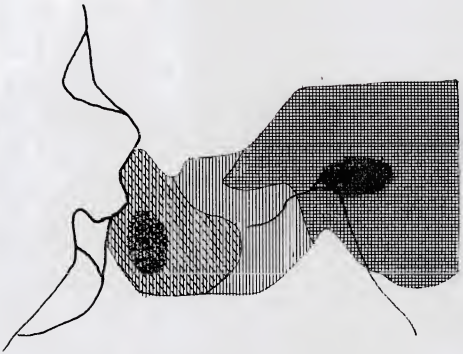


Figure 3. Winter home range of deer 60-76.



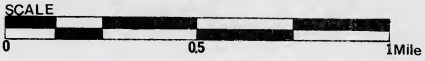


Figure 4. Winter home range of deer 4-76.

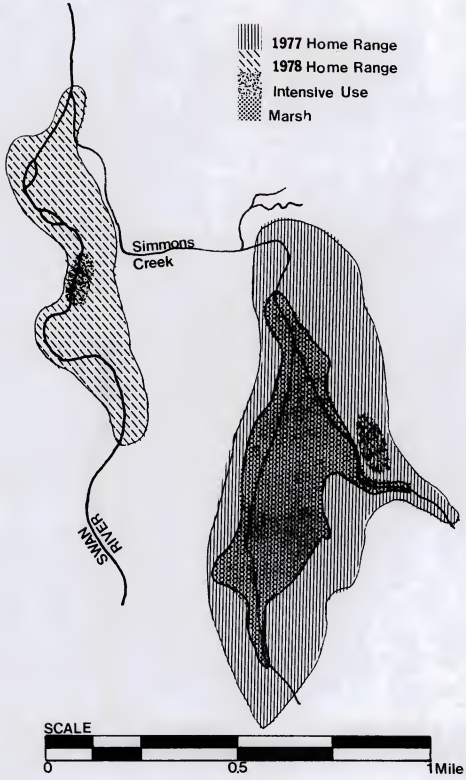


Figure 5. Winter home range of deer 25-77.

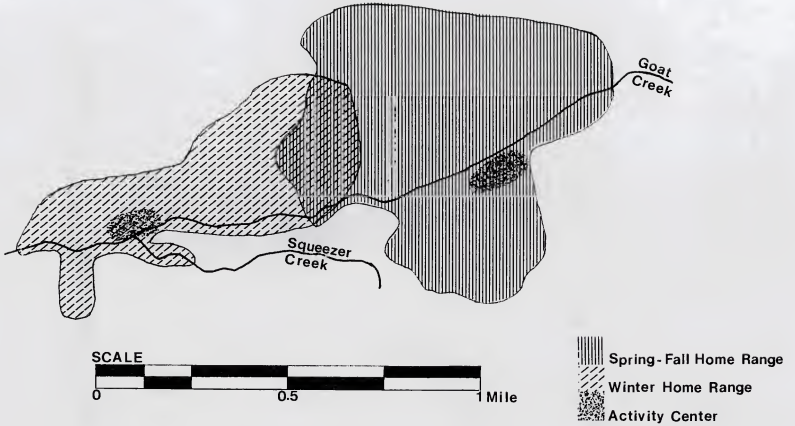


Figure 6. Winter home range of deer 41-78.

Deer #48-78 used three activity centers within a comparatively large winter home range (Fig. 7). During 1978 and 1979 she was found either near the confluence of Goat Creek and the Swan River or near a large pothole that flowed into Simmons Creek. During 1980, she was found either near that pothole or near the confluence of Goat and Squeezer Creeks.

Deer #56-78 wintered along Dog Creek in 1978-80. the area used in 1979 probably was her definitive winter home range (Fig. 8). She used an active timber sale area in 1978 and 1980. That area attracted unusual concentrations of deer those years, compared with deer use in 1976, 1977 and 1979.

Eleven radio-collared does were followed during two consecutive winters. Deer #50-76 wintered near Goat Creek. During 1976 and 1977 she used areas similar to those used by #60-76 (Fig. 3).

Deer #4-77 was a 1976-77 fawn of #4-76. Her 1978 and 1979 home ranges were similar to the 1978 and 1976 home ranges, respectively, of deer #4-76 (Fig. 4).

Deer #23-77 wintered near the confluence of Pony Creek and the Swan River. She used similar areas in 1977 and 1978.

Deer #56-77 wintered along Alder Creek in 1977 and near Squeezer Creek in 1978. The Alder Creek location was peripheral to the winter range. She used that location as an intermediate area in spring and fall 1977 and in spring 1978.

Deer #39-78 wintered near Cedar Creek in 1978. In Spring 1978 she used an intermediate area near Simmons Meadow. She returned to Simmons Meadow in fall 1978 and remained there for the 1978-79 winter.

Deer #'s 37-79 and 87-79 wintered near Dog Creek, in the vicinity of #56-78, during 1979. Deer #91-79 wintered approximately 1 mile southeast of there, near Simpson Creek. All were found in the active timber sale area during 1980.

Deer #74-79 wintered near the confluence of Lion Creek and the Swan River during 1979. She used an intermediate area, approximately 1 mile east of there, during spring 1979, and wintered in that area during 1980.

Deer #79-79 used similar wintering areas, near the confluence of Cedar Creek and the Swan River, during 1979 and 1980, and an intermediate area, near Squeezer Meadows in spring and fall 1979 and again in spring 1980. Deer #103-79 used similar winter home ranges, in the Goat Creek drainage, during 1979 and 1980.

A consistent range use pattern was apparent for all radio-collared does, despite variations in movements. Definitive winter home ranges were less than 160 acres. Each deer used an activity center(s) within riparian habitat. The activity center was a comparatively small portion of the home range, yet was the area in which individual deer predictably could be found. Gladfelter (1978) reported that white-tailed deer in Iowa used winter home ranges of 100-378 acres and that activity centers comprised less than 15% of the home range. Rognstad and Tester (1969) reported winter home ranges of 400-1,200 acres and indicated that deer concentrated their use in a small portion of their home range.

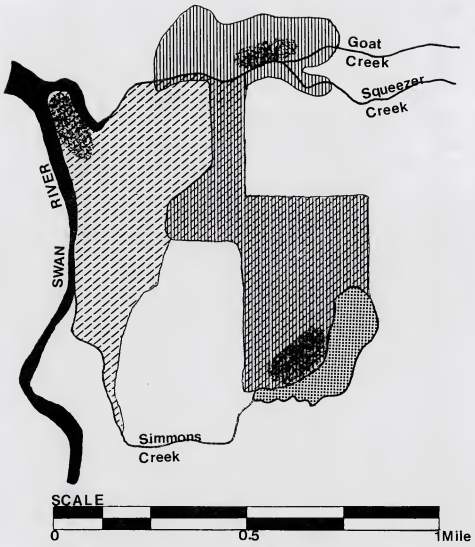


Figure 7. Winter home range of deer 48-78.

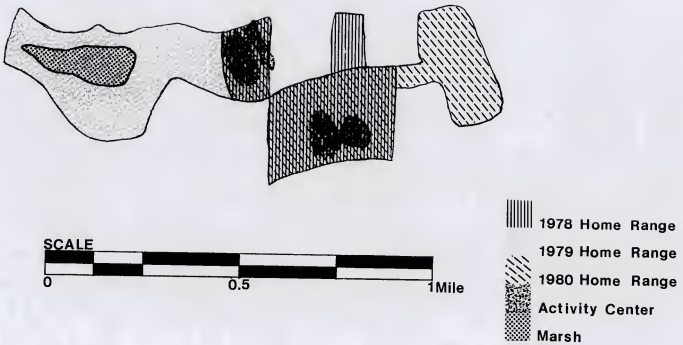


Figure 8. Winter home range of deer 56-78.

Each deer also used additional riparian habitat and a comparatively large area of upland habitat, accessible from the riparian area. Riparian areas were used for resting and security; uplands were used for foraging. As winter progressed, the cruising radius of each deer gradually was reduced. This occurred as a reduction in the amount of upland area used. This phenomenon was not observed during the mild 1977 winter. Rognstad and Tester (1969) reported that with increased snow depths, deer remained in the cedar swamps, upland foraging stopped, and home ranges decreased. Drolet (1976) reported an inverse relationship between home range size and snow depth.

The upper Swan Valley winter range is physiographically dissimilar from the winter range at Salmon Lake, approximately 35 miles south from Condon. The Salmon Lake winter range has greater topographic relief and is typified by open canopy forest habitat types within the *Pinus ponderosa* and *Pseudotsuga menziesii* series (Janke 1977). There, high deer use occurred on ridges and slopes that were first to be free of snow.

Food Habits

White-tailed deer food habits were determined by rumen analysis (Appendix Tables 1-8). Analysis of samples collected during 1980 has not been completed.

Deciduous browse predominated in the fall rumen samples. Oregon grape (*Berberis repens*) was the single most important species . Serviceberry (*Amelanchier alnifolia*) and snowberry (*Symphoricarpos albus*) also were important. Use of conifers was minor in fall. Greater use of forbs occurred in fall, relative to their occurrence in winter and spring samples. Bunchberry dogwood (*Cornus canadensis*) and twin-flower (*Linnaea borealis*) were prominent forbs.

Browse was the predominant forage class in the winter rumen samples. The use of conifers, particularly Douglas fir and common juniper (*Juniperis communis*), increased relative to the occurrence of conifers in the fall samples. Oregon grape was the most important forage species during the mild winters, 1976 and 1977. During those years, a variety of other deciduous browse species also was used. The most notable included serviceberry, kinikinnik (*Arctostaphylos uva-ursi*), evergreen ceanothus (*Ceanothus velutinus*), and willow (*Salix* spp.). Douglas fir was the most important forage species during the more severe winters, 1978 and 1979. Spurce and lodgepole pine were consistently used those winters. Arboreal lichens (*Allectoria* spp.) probably were important every winter, but use of that material was difficult to determine by rumen analysis.

Deciduous browse again predominated in the spring diet. The greatest use of Oregon grape occurred in that season. Other important species included serviceberry, kinikinnik, and Myrtle pachistima (*Pachistima myrsinites*). Common juniper and Douglas fir were important conifers, but the importance of conifers decreased in the spring diet. The use of forbs increased, relative to the winter diet, but forbs were less important than in the fall. Twinflower and bear grass (*Xerophyllum tenax*) were prominant forbs.

Winter food habits during this study generally were consistent with those reported for 1957 (Weckwerth 1958) and 1970 (Hildebrand 1971). Species composition in the diet was similar, except for the lack of snowbrush ceanothus in the 1957 samples. A greater percentage of Oregon grape occurred in the 1976

and 1977 samples than in those from 1957 and 1970. Bergeson (1943) indicated that the majority of food consumed was Douglas fir and arboreal lichens. Use of willow, mountain maple (*Acer glabrum*), serviceberry, ceanothus (*Ceanothus* spp.) and common juniper also was indicated. Oregon grape, huckleberry (*Vaccinium* spp.), and kinikinnik also were used during periods of reduced snow cover. Present data are consistent with those observations. Recent logging has altered the potential forage resource that is available to deer. Similarities among the 1943, 1957, 1970, and present food habits indicate that deer have not altered their diet, relative to that availability.

White-tailed deer winter food habits generally were similar to those reported for the Fisher River-Wolf Creek winter range (Firebaugh 1970; Flath 1971, 1972). In both areas, Oregon grape and Douglas fir were prominant items and the use of Douglas fir increased with decreasing availability, due to snow, of Oregon grape. A variety of deciduous browse species also was used as minor items.

Grasses and forbs were important items in the winter diet of white-tailed deer at Salmon Lake (Janke 1977; Slott 1979). Oregon grape and Douglas fir consistently were used, but in lesser quantities than in either the Swan or the Fisher River-Wolf Creek areas. Serviceberry was used to a greater extent at Salmon Lake.

Fawn Production

Observations of 3,949 white-tailed deer were made during January-April 1980. Of these, 3,889 were classified as fawns or adults (Table 10). The data indicated a fawn/adult ratio of 42.7/100, or a population comprised of 29.9% fawns.

Differentially greater fawn mortality, as compared with adults, was not evident from monthly classifications during any year of this study (Table 10; Appendix Table 9). Therefore, winter classifications were assumed to be reliable estimates of recruitment.

The recruitment rate averaged 29.5% for the period 1976-80. Similar rates were recorded each year, except that recruitment in 1979 was significantly less ($p < 0.10$) than that recorded in 1978. Recruitment during this study also was similar ($p > 0.10$) to that reported for 1970 (Hildebrand 1971). In prior years, recruitment estimates were higher, more variable, and derived from small samples (Table 11).

A sample of 382 deer was observed during the 5 replications of the upper Swan Valley trend route. The recruitment rate indicated by that sample was similar to that derived from observations throughout the winter (Table 10). Trend route samples during 1977 and 1978 also were adequate to determine the recruitment rate (Mundinger 1978), however, the sample observed in 1979 was too small (Mundinger 1979).

Individual adults, that were accompanied by fawn(s), were presumed to be does. Those animals were tallied to determine a ratio of twin/singleton litters. Values were 0.32, 0.42, 0.29, 0.19, and 0.29, respectively, during each of the five winters.

Classifications of animals harvested during the either-sex portion of the hunting season generally indicated a lower recruitment rate than that derived

Table 10. Monthly classifications of white-tailed deer in the Upper Swan River Valley during winter, 1980.

Month	Total	Adults	Fawns	Uncl.	ff/100 Ad.	% ff
January	221	155	60	6	39	27.9
low[1]		44	12		29	
high[2]		45	24		53	
February	1,293	881	392	20	44	30.8
low		91	30		33	
high		67	36		54	
March	2,129	1,474	627	28	43	29.8
low		104	36		35	
high		130	65		50	
April	306	216	84	6	39	28.0
1980 Total	3,949	2,726	1,163	60	43	29.9
Trend Route	382	265	115	2	43	30.3
1979 Total	3,100	2,224	840	36	38	27.4
1978 Total	4,198	2,707	1,295	196	48	32.4
1977 Total	3,743	2,429	1,010	304	42	29.4
1976 Total	2,269	1,519	600	150	39	28.3

[1] Daily classification with the lowest fawn/adult ratio during the month.

[2] Daily classification with the highest fawn/adult ratio during the month.

from winter observations (Table 12). Similarly, recruitment estimates derived from trapping samples (Table 13) and highway mortality samples (Table 14) did not always agree with those derived from winter observations.

Yearlings consistently were well represented in the harvest (Table 15). Harvests probably were biased in favor of that age-class, especially yearling males, because yearlings comprised a higher percentage of adults in the annual harvests than would have been predicted from corresponding winter classifications (Table 7). Although the hunting season data may not have been an accurate assessment of population age-structure, they indicated that survival from 8 to 18 months was high.

Several sources provided estimates of fawn sex ratios (Table 16). Those estimates varied both within and between years and the variations were not consistent. Apparently, sample sizes were insufficient to determine this parameter.

Table 11. White-tailed deer fawn/adult ratios in the Swan River Valley, 1958- 1980.

Year	Adults	Fawns	Fawns/ 100 adults	Percent Fawns
1958	167	99	59	37
1959	207	68	33	25
1960	77	30	39	28
1961	19	8	42	30
1962	80	33	41	29
1963	59	31	53	34
1964	234	90	38	28
1965	188	108	57	36
1966	33	17	52	34
1967	51	26	51	34
1968	30	26	80	46
1969	122	55	45	31
1970	249	112	45	31
1971	66	28	42	30
1972	42	13	31	24
1976	1,519	600	39	28
1977	2,429	1,010	42	29
1978	2,707	1,295	48	32
1979	2,224	840	38	27
1980	2,276	1,163	43	29

Table 12. Either-sex hunting season classifications.

Year	Fawns/100 Adults	Fawns/100 Females	Adult Males/100 Adult Females
1975	45	87	93
1976	27	55	100
1977	36	70	94
1978	35	69	94
1979	39	62	59

Table 13. Percent composition by sex and age-class of white-tailed deer trapping sample.

Age-Class	Females				Males				Total			
	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
½	24	29	26	28	55	68	66	69	35	40	39	42
1½	12	17	22	17	12	23	18	18	12	19	20	18
2½	14	9	17	9	7	5	7	3	12	8	14	7
3½	9	12	14	15	2	0	9	3	7	9	12	11
4+	41	33	22	31	24	5	0	8	35	25	14	23
Sample Size	76	58	88	81	42	22	44	39	118	80	132	120

Table 14. Percent composition by sex and age-class of white-tailed deer road-kill sample.

Age-Class	Females					Males					Total				
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980
½	25	28	35	32	44	29	33	77	38	86	27	30	49	33	63
1½	25	6	10	11	19	14	11	9	25		20	7	10	15	10
2½		17	13	16	13	14	33		25	14	7	22	9	19	13
3½	13	28	13	11	6	29		5			20	19	10	7	3
4+	38	22	29	32	19	14	22	9	13		27	22	23	26	10
Sample Size	8	18	48	19	16	7	9	22	8	14	15	27	70	27	30

Table 15. Percentages of yearlings in the harvest of white-tailed deer.

Year	% of Adult females	% of Adult males	% of Adults	% of Total Harvest
1975	20	39	33	26
1976	55	44	47	43
1977	24	52	44	37
1978	38	49	46	51
1979	17	48	34	30

Table 16. Comparative estimates of fawn sex ratios (♀♀/♂).

Year	Source			
	In utero	Check station	Trapping	Road-kill
1975-76	.	1.4:1	0.8:1	1.0:1
1976-77	0.5:1	0.3:1	1.1:1	1.7:1
1977-78	0.5:1	1.3:1	0.8:1	1.1:1
1978-79	1.1:1	0.8:1	0.9:1	2.0:1
1979-80	0.4:1	0.9:1		0.6:1
1980-81	1.0:1			

Data from female reproductive tracts, collected during this study, are summarized in Appendix Table 10. The reproductive potential of the Swan Valley population was estimated from that sample and collections made in 1970 (Hildebrand 1971:30) (Table 17). Yearlings comprised the youngest breeding age-class; no pregnant fawns were examined. Ninety-six percent of all does, yearling and older, was pregnant. The fetal rate for all females was 1.52/doe and 1.59/pregnant doe. The ovulation rate was 1.73/doe. The highest fetal rate was recorded for 3½-year-old does, while the highest ovulation rate occurred in the oldest age-class. Comparisons with other studies (Cheatum and Severinghaus 1950; Ransom 1967; Roseberry and Klimstra 1970) indicated that the reproductive potential of the Swan Valley population is less than that reported for the species. Two recent collections have been made at Salmon Lake (Janke 1977; Slott 1979). Those were too small to compare with my data, but each included one pregnant fawn and one older adult female which bore triplets.

Conception dates were predicted with an equation for estimating fetal age from the forehead-rump length (Short 1970:385). For this sample of 46 does, the estimated fetal ages ranged from 54-130 days. Estimated conception dates ranged from 14 November-23 December. Twenty-two percent of the does conceived

Table 17. White-tailed deer reproductive potential, by age-class, as determined from 1970[1] and 1976-80 collections of reproductive tracts in the Swan Valley.

Age-Class	Sample Size	Percent Pregnant	Fetuses per Doe	Fetuses per Pregnant Doe	Ovulation Rate[2]
½	40	0			
1½	20	95	1.18	1.23	1.42
2½	17[3]	94	1.47	1.57	1.67
3½	28	100	1.72	1.72	1.61
4½	15	93	1.64	1.80	2.0
5+	22	95	1.65	1.75	2.07

[1] 1970 data from Hildebrand (1971:30)

[2] Ovulation rates from 1976-80 data only

[3] The non-parous female in this sample had aborted (Hildebrand 1971)

in each of the intervals, 14-20 and 21-27 November; 43% conceived between 28 November and 4 December; the remaining 13% conceived between 7-23 December. Slott (1979) estimated a breeding season of 19 November - 6 December from a sample of 9 does collected at Salmon Lake.

A 200-day gestation period was assumed (Cheatum and Severinghaus 1956). Estimated parturition dates ranged from 30 May - 8 July, with a peak during 13-19 June.

Fetal ages also were estimated from fetal weight (Short 1970:385). Those ages consistently were younger than those predicted from forehead-rump length. The average for the sample was 7 days younger. Ages predicted from fetal weight are less reliable than those predicted from forehead-rump length (Short 1970). However, the consistent discrepency suggests that fetal weight gain did not keep pace with fetal growth. That may have resulted from nutritional stress.

The reproductive performance of 19, 45, 61, 78, and 70 individually marked does was determined from field observations during the five respective winters. Most of these determinations were made between mid-January and early April. Repeated observations substantiated many doe-fawn associations. Those repeated observations also confirmed other indications that over-winter fawn survival was high. Therefore, as with classification data, production rates, as determined from the sample of marked does, were assumed to be representative of recruitment.

The reproductive success of collared does was consistent with the recruitment rate for the population as a whole (Table 18). Cumulatively, 113 of 219 does, 2½-years-and-older, successfully reared 130 fawns. Productivity was 59 fawns/100 does. That represented a loss of 60% of the potential fawn production.

Table 18. Reproductive performance of marked does by age-class.

Age-Class	1½	2½	3½	4½	5+	Total	2+
1976							
Number of does	3	3	2	5	6	19	16
Number of successful does	0	1	1	3	5	10	10
Percent success		33	50	60	83	53	63
Number fawns		1	1	3	7	12	12
ff/100 does		33	50	60	117	63	75
1977							
Number of does	13	5	8	2	17	45	32
Number of successful does	0	1	3	2	10	16	16
Percent success		20	38	100	59	36	50
Number fawns		1	3	2	15	21	21
ff/100 does		20	38	100	88	47	66
1978							
Number of does	14	18	10	8	11	61	47
Number of successful does	0	8	8	5	8	29	29
Percent success		44	80	63	73	48	62
Number fawns		8	8	5	10	31	31
ff/100 does		44	80	63	91	51	66
1979							
Number of does	16	16	11	7	28	78	62
Number of successful does	0	9	3	3	16	31	31
Percent success		56	27	43	57	40	50
Number fawns		9	3	3	18	33	33
ff/100 does		56	27	43	64	42	53
1980							
Number of does	8	14	15	8	25	70	62
Number of successful does	0	4	7	2	14	27	27
Percent success		29	47	25	56	39	44
Number fawns		4	8	3	18	33	33
ff/100 does		29	53	38	72	48	53

Table 18. Continued.

Age Class	1½	2½	3½	4½	5½	Total	2+
Total							
Number of does	54	56	46	30	87	273	219
Number of successful does	0	23	22	15	53	113	113
Percent success		41	48	50	61	41	52
Number fawns		23	23	16	68	130	130
ff/100 does		41	50	53	78	48	59

None of the yearlings in this sample was observed with fawns. That was consistent with the lack of pregnant fawns in the sample of reproductive tracts.

Forty-one percent of the 2½-year-old does was observed with fawns (Table 18). That contrasted with a pregnancy rate of 95% for the yearling age-class (Table 17). Potential production for this age-class was 118 fawns/100 does. The observed fawn/doe ratio of 41/100 represented a 65% fawn loss between pregnancy and the subsequent winter.

Forty-eight percent of the 3½-year-old does was observed with fawns, in contrast with 94% pregnancy rate and 1.47/doe fetal rate observed for 2½-year-olds. One doe in this group had twins. The fawn/doe ratio for 3½-year-olds represented a 66% fawn loss.

Fifty percent of the 4½-year-old does was observed with fawns; one had twins. That contrasted with a 100% pregnancy rate and a fetal rate of 1.72/doe. The observed fawn/doe ratio represented a 69% fawn loss in this age-class.

Sixty-one percent of all does, 5½-years-and-older, was observed with fawns. Sixteen percent of the old does and 26% of those which successfully reared fawns were observed with twins (includes one doe with triplets). Those observations contrasted with a pregnancy rate of 95%, a fetal rate of 1.64/doe, and a potential for 71% twin-fawn litters for 4+-year-old does. The rate of fawn loss was 52% for old does. The reproductive success rate of old does was less variable, between years, than that of the younger age-classes.

The reproductive performance of individuals during two or more consecutive years was determined from observations of 49 marked, adult does, 2½-years-and-older (Table 19). That sample provided 71 cases of 2-year reproductive histories. Does successfully reared fawns only in alternate years in 36 (51%) of the cases. There were 22 (31%) cases of reproductive failure in consecutive years; 13 of those involved does that were 4½-years-old or younger. There were 13 (18%) cases of reproductive success in consecutive years; ten of those involved does that were 5½-years-old or older.

Fifteen does provided 21 cases of 3-year histories. There were 2 cases of reproductive failure in 3 consecutive years. Nine cases each of successful

Table 19. Reproductive histories of 49 individual marked deer.

Deer No.	Estimated Age When Trapped	Number of fawns in 1976	Number of fawns in 1977	Number of fawns in 1978	Number of fawns in 1979	Number of fawns in 1980
4-76	5½		2	0	1	
27-76	2½	0	0	1	1	
29-76	5½	2	2			
36-76	3½	0	1		1	
41-76	6½	1	1			
44-76	½			1	0	
49-76	4½	1	0			1
50-76	5½	2	0			
51-76	2½		0	1	0	1
55-76	6½	1	1		1	0
60-76	4½	0	0	0	1	
62-76	½			1	0	0
63-76	4½				0	0
69-76	6½	0	1	1		
74-76	2½		0		0	1
75-76	4½	1	0	1		
79-76	2½		0	1	1	2
85-76	2½	0	0	0		
86-76	7½	0	2	1		
92-76	4½		0	1		
100-76	6½			2	0	
107-76	5½			1	0	
4-77	½				1	1
5-77	½				0	0
6-77	1½			0	0	
25-77	1½			0	0	
27-77	½				0	0
60-77	3½		1	0	0	1
27-78	4½			1	0	0
41-78	3½			1	0	0
48-78	2½			0	0	1
56-78	3½			1	0	3
66-78	1½				1	0

Table 19. Continued.

Deer No.	Estimated Age When Trapped	Number of fawns in 1976	Number of fawns in 1977	Number of fawns in 1978	Number of fawns in 1979	Number of fawns in 1980
71-78	3½				0	1
74-78	1½				1	1
102-78	1½				1	1
103-78	2½			1	0	
104-78	1½				1	0
107-78	4½				1	1
115-78	5½			0	1	1
1-79	2½				0	0
8-79	5½				0	0
12-79	5½				0	0
27-79	5½				2	0
46-79	3½				0	0
55-79	3½				1	0
76-79	8½				0	0
91-79	3½				0	0
103-79	2½				0	0

production in 1 of 3 and 2 of 3 years were recorded. One doe successfully reared young in 3 consecutive years.

Five does provided 4-year histories. Three of these were successful in two years; one each was successful in 1 of 4 and 3 of 4 years.

Further evidence of alternate year production was provided by the reproductive success rates for individual cohorts in consecutive years (Table 20). Generally, the sum of success rates in any two consecutive years did not exceed 100%.

Table 20. Percent reproductive success in consecutive years by individual cohorts.

Cohort	Year 1976	1977	1978	1979	1980
1971	60	40			
1972	50	100			
1973	33	38	63	29	75
1974		20	80	43	57
1975			44	27	25
1976				60	47

Survival

Four hundred and eleven white-tailed deer were captured and marked for individual recognition during this study. Of those, 88 were known to be alive at the time of spring dispersal in 1980 (Table 21a).

Seventy-four marked deer were known mortalities (Table 21b). Those included 33 hunting losses, 22 highway mortalities, 8 winter-kills, 5 coyote-kills, and 6 from other causes (Table 22).

The fate of 249 marked deer had not been determined by spring 1980 (Table 21c). That group included both animals which had lost collars and undetected mortalities. It also included other marked animals which are still in the population. Certain deer may have been captured while they were occupying transitional range and intensive observations may not have been made within their respective winter home ranges. Other deer may have been present within areas of intensive observations, yet were not seen. The sample of marked animals included 63 deer that were not observed for one or more years and subsequently were either seen or were known mortalities. Extremes included 3 deer that first were seen 3 years after capture and one doe that first was observed 4 years after capture.

Emigration also occurred during this study, but the extent was not known. I obtained 3 reliable reports of collared white-tailed deer in areas outside of the Swan and Clearwater drainages, but the observers had not positively identified the collar. It is probable that at least two of these animals were trapped in the Swan.

Annual survival and mortality rates were determined from numbers of known survivors and known mortalities within individual cohorts (Tables 23 and 24). Those rates suggested that survival varied between year-classes, within a sex-class, and that female survival was higher than that of males.

Average annual survival and mortality rates also were determined by sex/age-class (Tables 25, 26 and 27). Samples of marked females were sufficient to determine survival rates through several years. Certain inconsistencies occurred in those data. For example, the cumulative survival rates of $2\frac{1}{2}$- and $3\frac{1}{2}$-year-old females were higher through 7-years than through 6-years. Likewise, the cumulative mortality rates of those age-classes were higher through 6-years than through 7-years. Those inconsistencies were artifacts of pooled samples and they further demonstrated that survival varied between cohorts.

Annual survival rates were 54.6%, 69.8% and 65.2% for all males, all females, and all animals, respectively. These rates were conservative estimates of survival because they assumed that all unaccounted animals had died. Longevity of adult females also indicated that these rates were conservative. In most instances, the survival of females, $2\frac{1}{2}$-years-and-older, through 2 or more years implied a higher survival rate than that observed for the first year. For example, the annual survival rate of $3\frac{1}{2}$-year-old females was 66%. Yet, average annual survival rates of 56%, 72%, and 82% were inferred from known survival through 5-, 6-, and 7-years, respectively.

Because rates determined from the pooled sample were conservative, those values established the lower-limit for interval estimates of known female

Table 21. Fate of animals within yearly samples of marked deer.

A. Number of known survivors

Sample Year	Sample Size	1976	1977	1978	1979	1980
1976	115	86	57	31	19	9
1977	69		40	23	15	7
1978	118			100	60	35
1979	109				68	37

B. Number of known mortalities

Sample Year	Sample Size	1976	1977	1978	1979	1980	Total
1976	115	3	11	12	2	1	29
1977	69		4	7	4	2	17
1978	118			7	5	6	18
1979	109				5	5	10

C. Number of unobserved animals

Sample	Sample	Year of Last Observation					
Year	Size	Never	1976	1977	1978	1979	Total
1976	115	26	18	14	10	9	77
1977	69	25		10	4	6	45
1978	118	11			35	19	65
1979	109	36				26	62

survival (Table 28). Sub-samples of individual female cohorts in single years were examined to derive several estimates of survival for each age-class. The highest rate for each age-class was selected and these established the upper-limits of the estimates.

Survival also was estimated with a life table, calculated by computer population simulation (Mooney and Lonner 1978) (Table 29). Survival rates of animals, 1-year-and-older, were 64.5%, 76.0%, and 71.7%, respectively, for males, females and all adults.

The model was scaled to a population of 1,000 animals and assumed age-specific recruitment rates (Table 18) and a ratio of 39 fawns/100 adults. Prior to initialization, a 1:1 fawn sex ratio was assumed. That ratio was adjusted,

Table 22. Known mortalities of marked white-tailed deer.

Year	Sample	Cause of Mortalities				
		Hunting	Road-kill	winter kill	coyote kill	other
1975-76	1976		1	1	1	
1976-77	1976	5	2	2		2
	1977		2	1	1	
1977-78	1976	9	3			
	1977	2	3		1	1
	1978		3	2	2	
1978-79	1976		1			1
	1977	3	1			
	1978	5				
	1979		3	2		
1979-80	1976	1				
	1977	1	1			
	1978	3	1			2
	1979	4	1			
Total		33	22	8	5	6

Table 23. Annual survival and annual mortality rates of marked male cohorts.

Cohort	% Known Survival by Year					% Known Mortality by Year					Age at 1 June 80
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980	
1975	40	33	80	25	0	0	33	20	25	0	6
1976	77	52	50	29	0	5	19	33	14	0	5
1977		43	64	44	50		0	7	33	25	4
1978			89	50	50			7	6	19	3
1979				56	27				4	20	2

Table 24. Annual survival and annual mortality rates of marked female cohorts.

Cohort	% Known Survival by Year					% Known Mortality by Year					Age at
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980	1 June 80
1974	80	86	75	78	71	0	7	17	11	0	7
1975	78	58	57	50	83	11	8	19	0	17	6
1976	78	82	62	59	53	6	0	14	4	20	5
1977		76	79	77	70		0	3	3	9	4
1978			87	83	54			9	0	4	3
1979				65	60				9	0	2

Table 25. Annual survival and mortality of marked males by age-class.

	Age-Class					
	½	1½	2½	3½	4½	5+
% known survival	69	48	49	42	17	67
% known mortality	4	11	26	21	17	0

Table 26. Longevity of marked females by age-class.

Age-Class	% known survival to age-class:							% known mortality to age-class:						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
½	77	60	41	20	11			6	7	14	20	28		
1½		78	52	28	10	0			2	9	18	29	56	
2½			66	44	24	23	40			7	15	22	27	10
3½				66	37	34	36				9	18	26	29
4½					58	50	42					13	17	25
5½						80	56						13	11
6½							71							0

Table 27. Longevity of marked 4+-year-old females.

	Years				
	1	2	3	4	5
% known survival to year	67	46	33	16	20
% known mortality to year	8	18	24	24	10

Table 28. Interval estimates of female survival rates, derived from known survival of marked white-tailed deer.

Age-Class	% Known Survival Interval	Mid-Point
½	77 - 87	82.0
1½	78 - 83	80.5
2½	66 - 80	73.0
3½	66 - 86	76.0
4½	58 - 75	66.5
5½	80 - 83	81.5
6½	71 - 84	77.5
7+	67 - 74	70.5

Table 29. Sex and age structure of a simulated, stable population of 1,000 white-tailed deer.

Age-Class	Females	Survival	Males	Survival
1	148	1.0	132	1.0
2	115	0.78	92	0.70
3	96	0.83	57	0.62
4	77	0.80	36	0.62
5	57	0.75	22	0.62
6	41	0.71	13	0.60
7	28	0.68	8	0.60
8	19	0.68	5	0.60
9	13	0.68	3	0.60
10+	34	0.65	4	0.59

consistent with the known survival of marked male and female fawns (Tables 25 and 26). Except for that adjustment, survival rates determined with the model were independant from other estimates. The population was manipulated with the model to determine the minimum number of females and the female age-structure that were necessary to maintain a stable population. Then, male survival was adjusted so that the male segment also was stable.

The model followed the biological year. The simulation represented those animals present at the end of the year, i.e. after all mortality had occurred but prior to births and the advancement of cohorts to the next age-class. The model used recruitment rates in place of birth rates. Because recruitment presupposed all fawn mortality, it was necessary to assume 100% survival for that age-class.

The adult sex ratio of the Swan Valley population was not known and that parameter was not assumed in the model. Rather, adult males were all animals that remained after fawns and females were put into the model. The adult sex ratio of the simulation was 50 males/100 females. That value was considerably less than that observed in the harvest (Table 12), but greater than that observed in the trapping (Table 13) and highway mortality (Table 14) samples.

Male and female survival rates also were estimated from the harvest age-structure (Table 7) (Eberhardt 1969:474). Those estimates assumed a constant recruitment rate, uniform survival through all age-classes, and that the sample was representative of the population age-structure. Ideally, the technique should have been applied to collections from a single hunting season, but data were pooled for this analysis. This technique had statistical advantages because a confidence interval could be calculated and the assumption of uniform survival could be tested. The latter test did not prove uniform survival, but rather determined whether the observed age distribution was consistent with the expected age distribution, if uniform survival was assumed.

Fawns were not considered in the analysis of males because the season format precluded a representative sample. The survival rate of all males, yearling and older, was not consistent with the assumption of uniform survival ($p < 0.01$). The survival rate of adult males, 2½-years-and-older, was 0.601 ± 0.045. That value was consistent with the assumption ($p = 0.25$).

The survival rate for all females was 0.695 ± 0.034. That value was consistent with the assumption of uniform survival ($p = 0.15$).

There were limitations to each of the various survival estimates. The sample of marked deer contained many animals the fates of which were unknown. The adult sex-ratio of the simulated population could not be verified with representative field data. The analysis of harvest data required simplistic assumptions. Yet estimates of survival were derived by three independent methods and there was general agreement among those estimates. Moreover, the various estimates of survival were consistent with the average recruitment rate.

Trend Route

It is difficult to observe deer in the mature, coniferous forest and a practical method to census deer in that habitat is not available. I, therefore, attempted to determine the population trend from replicated, direct counts of deer from an established vehicle transect through the winter range (Table 30). Those counts were influenced by many variables other than total numbers of deer. Thus, they were not sensitive to minor fluctuations, but they probably would have been indicative of large changes.

The trend counts have value when interpreted relative to other data. Large changes in the population level were not apparent from the annual harvests (Table 1). The consistency between recruitment and the various estimates of survival implied a stable population. The trend counts did not contradict that conclusion.

Table 30. Summary of upper Swan Valley trend routes.

Date	# Deer/Mile Year 1977	1978	1979	1980
1/6		1.6		
1/12-1/16	0	0.1	0.6	1.6
1/23-2/3	0.4	0.7	1.0	
2/9-2/16	2.4	3.5	1.7	4.2
2/24-3/3	4.2	1.0	3.5	4.2
3/12-3/16	5.3	7.3		7.1
3/26-3/30	3.9	3.0		6.0
4/12-4/15	1.0	0.4		

Condition

Kidney fat indices (Riney 1955) for 1976 and 1977 are presented in Table 31. Femur fat assays (Verme and Holland 1973) for 1978-80 are presented in Table 32. It was apparent from those data that white-tailed deer in the Swan Valley incur an annual fat cycle (Mautz 1978), and that the fat cycle was evident every year, regardless of winter severity.

Table 31. Kidney fat indices of white-tailed deer in the Swan Valley.

Date	Fawns ♂♂	Fawns ♀♀	Adults ♂♂	Adults ♀♀
January 1976			127	338
February 1976			21	
March 1976	19	9	32	120
March 1977	1	4	2	57

Table 32. Percent femur marrow fat of white-tailed deer in the Swan Valley.

Date	Fawns ♂♂	Fawns ♀♀	Adults ♂♂	Adults ♀♀
January 1978	84	89	87	90
February	75	83		92
March	28	20	57	69
January 1979				97
February	70	55	87	91
March	90		52	77
April				30
January 1980		73		100
February	52			93
March	33	45	55	68

The fat cycle also was apparent from the progressive decline in condition that was indicated by the qualitative descriptions of carcasses. All animals were in excellent condition in the fall. Heavy fat deposits were evident on the briskets of harvested animals. From carcasses which had been skinned it also was apparent that fat had been deposited throughout the subcutaneous area, with heavy accumulations on the rump and over the saddle. Hunters regularly commented on the heavy visceral fat deposits encountered while field-dressing their game.

Adult females generally retained good to excellent condition through mid-January, although evidence of fat mobilization was evident in animals encountered by that time. Thereafter, the condition of adult females declined, but by late March carcasses still retained visible traces, or more, of fat in the subcutaneous and visceral areas.

Most fawns, of both sexes, were in good condition through mid-January and retained visible levels of subcutaneous and visceral fat through the end of February. Those reserves generally were nearly depleted by mid-March. At approximately that time, occasional live fawns with rough pelage were observed.

Adult males still retained moderate amounts of subcutaneous fat by the end of the hunting season, but deterioration, relative to their condition in late October, was apparent. Winter samples of adult males were small and this group was more variable than does and fawns, but the general trend seemed to be similar to that of fawns. By mid-March, most live animals, distinguishable as adult males, obviously were in poor condition.

Bergeson (1943) had conducted strip census throughout the winter range. From those he estimated over-winter mortality at approximately 4 dead deer per square mile. He also indicated that that estimate may have been excessive because it assumed that carcasses were uniformly distributed, yet he found most within areas of heaviest deer concentration. Hildebrand (1971) indicated that over-winter mortality was 24 and 23 dead deer per square mile in 1969 and 1970, respectively. Those values were determined from totals of 14 and 12 dead deer, respectively, encountered on 22 miles of transects within the area of heaviest concentration. Systematic sampling for dead deer was not conducted during this study. However, considerable time was spent within areas of heavy deer concentration and few carcasses were encountered. Therefore, it is probable that mortality was considerably less than that indicated by Hildebrand (1971). It also is possible that losses occurred during spring dispersal and that those may have been more extensive. Animals were in poorest condition at that time. Two old adult females, equipped with transmitters, had died, apparently from malnutrition, at that time during this study.

Although mortality could not be quantified, other observations suggested that over-winter mortality could not have been extensive. Had over-winter mortality been high, fawn mortality probably would have been excessive (e.g. Mackie et al. 1979), yet fawn mortality was not evident from classifications. Moreover, survival estimates were not consistent with extensive winter mortality.

Movements

Nine radio-equipped deer were followed in 1976 (Fig. 9). Nine deer, four of which were included in the 1976 sample, were followed in 1977 (Fig. 10). The 1978 sample (Fig. 11) included 19 deer, of which four were in the 1976

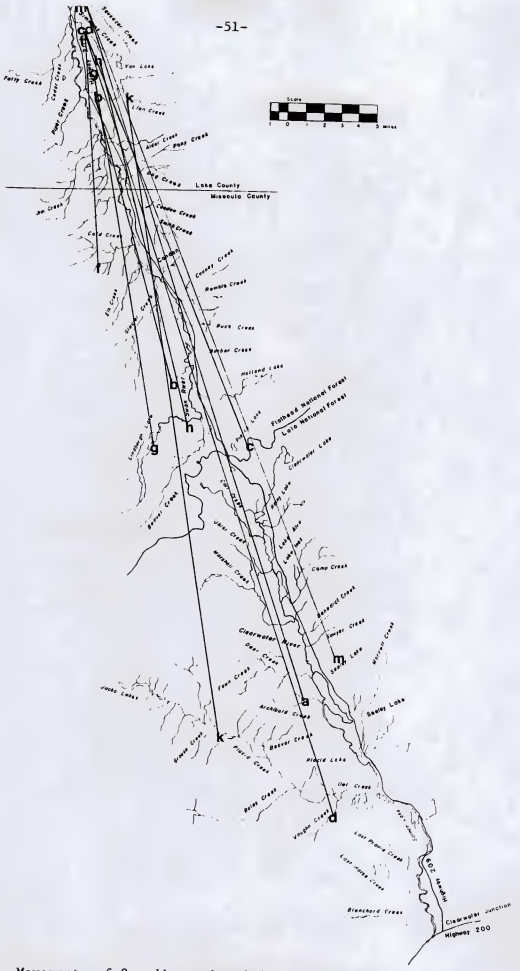


Figure 9. Movements of 9 radio-equipped deer during 1976.

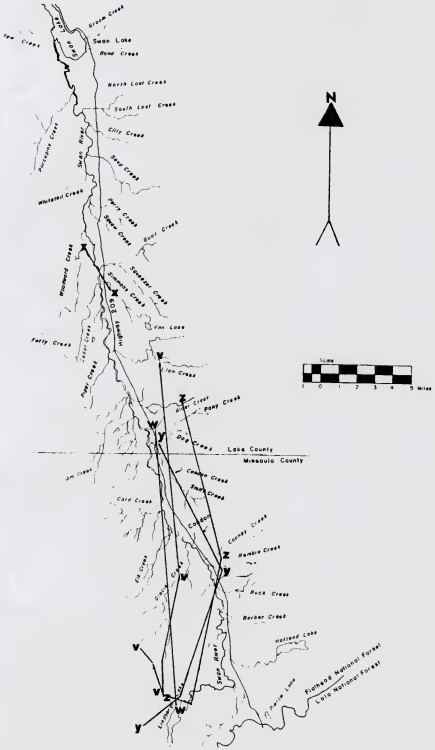


Figure 10. Movements of 5 radio-equipped deer during 1977.

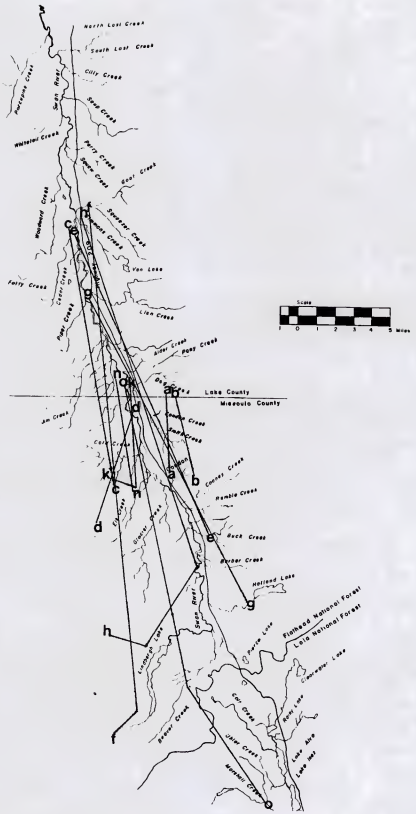


Figure 11. Movements of 11 radio-equipped deer during 1978.

sample, and three were from the 1977 sample. Seventeen deer were followed during 1979. That included one deer from 1977, 7 deer from 1978, and nine deer which were collared in 1979 (Fig. 12). No additional animals were collared during 1979-80, but 11 live does still carried functional transmitters during summer 1980. That included five and six animals from the 1978 and 1979 samples, respectively. Distributional histories of individual animals were previously discussed (Mundinger 1978; 1979). Movements of current instrumented animals during 1980 were similar to those observed in prior years.

Each radio-collared deer used recognizable summer and winter ranges, and each was faithful to those areas. Certain deer also occupied distinguishable intermediate areas during spring, and in several instances these areas were reoccupied in the fall. Other deer apparently were able to satisfy their spring and fall range requirements within their winter and summer home ranges and along the travel route between them. Deer moved directly between seasonal ranges or between seasonal and intermediate ranges. Rognstad and Tester (1969) also observed direct movements from winter to summer ranges.

The average straight-line distance between winter and summer home ranges was 19 miles (s.e.=0.32), and ranged from 3-44 miles. Movements between seasonal ranges averaged 9 miles, and ranged from 4 to 12 miles, for white-tailed deer which winter at Salmon Lake (Janke 1977). Gladfelter (1978) reported average movements of 14 miles and a range of 0-44 miles.

Mass migration did not occur. Rather, white-tailed deer behaved as individuals in their movements. Deer which wintered in close proximity often summered in distinctly different areas, and the converse also was true. The timing of movements occurred as individual events, such that certain deer left the winter range at the onset of spring, while others remained through early June. Deer were consistent in this behavior, and departures occurred in a predictable sequence. Similar observations were reported for mule deer in the Bridger Mountains (Mackie and Knowles 1977).

The distribution of hunter tag returns is presented in Figures 13, 14, 15,and 16. Areas used and distances moved generally were consistent with the migration patterns indicated by the radio-collared animals.

Summer distribution and range use

White-tailed deer summered throughout the Swan Valley at low to mid-elevations. The majority of deer that wintered in the upper Swan summered between Condon and the Swan-Clearwater divide, south of the winter range. Movements of marked deer indicated that lesser numbers summered in the Clearwater River drainage. In that area the summer distribution overlapped with that of deer which disperse from the Salmon Lake winter range (Janke 1977; Slott 1979). Deer also summered north of the winter range, between Goat Creek and Swan Lake. One tag return was obtained from Porcupine Creek and a few summer observations of collared deer have been reported in that area. Presumably, the Goat Creek-Swan Lake summer population included a few deer that wintered in the upper Swan and the majority wintered in the lower Swan.

Similarities were evident in the summer range-use patterns of radio-equipped deer. Summer home ranges occurred in closed-canopy forest. A variety of habitat types, within the *Pseudotsuga menziesii, Abies grandise,* and *Abies*

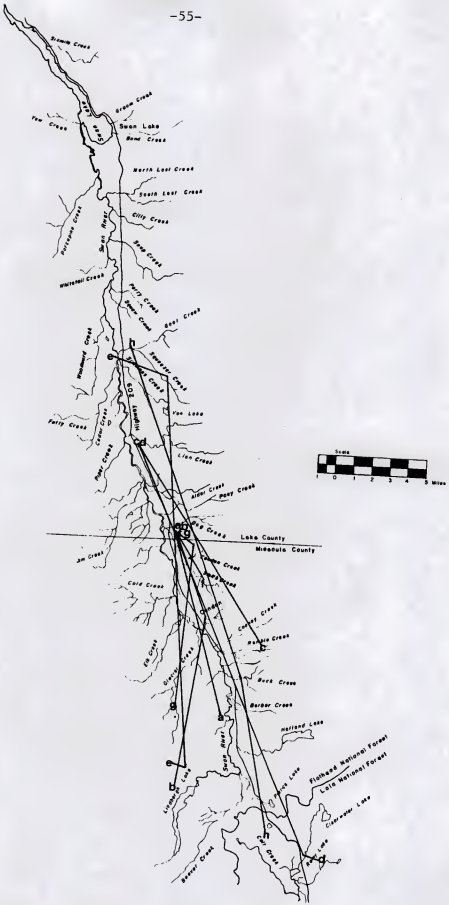


Figure 12. Movements of 8 radio-equipped deer during 1979.

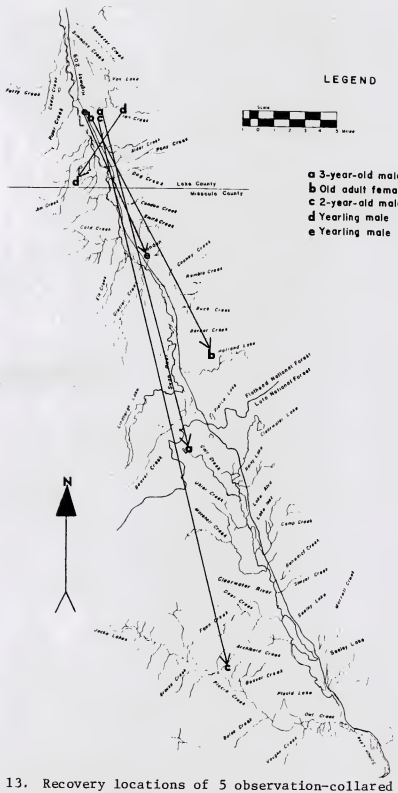


Figure 13. Recovery locations of 5 observation-collared deer during the 1976 hunting season.

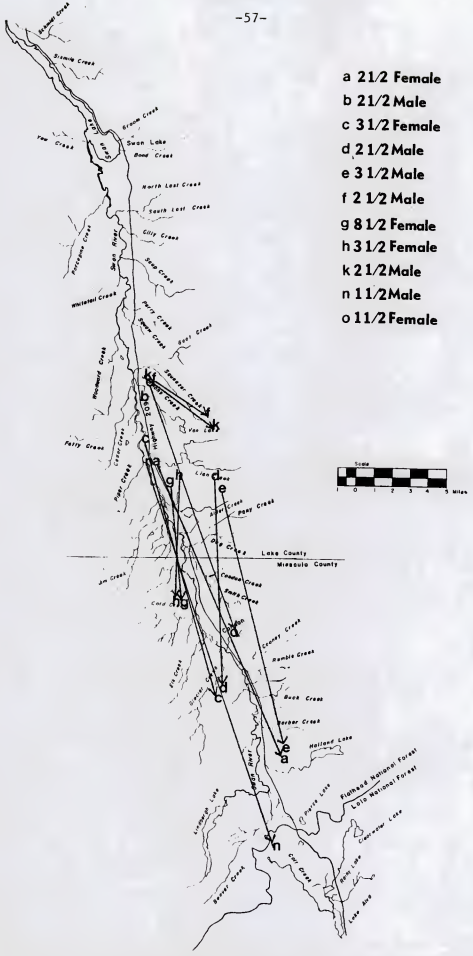


Figure 14. Recovery locations of 11 observation-collared deer during the 1977 hunting season.

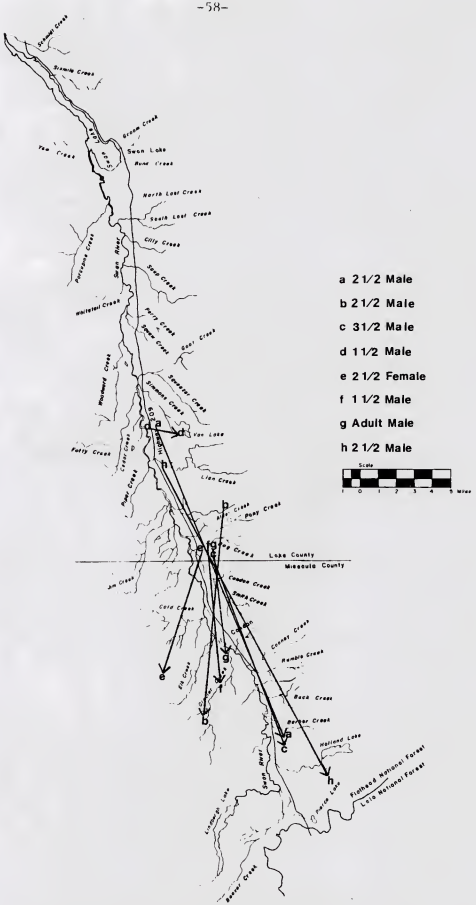


Figure 15. Recovery locations of 8 observation-collared deer during the 1978 hunting season.

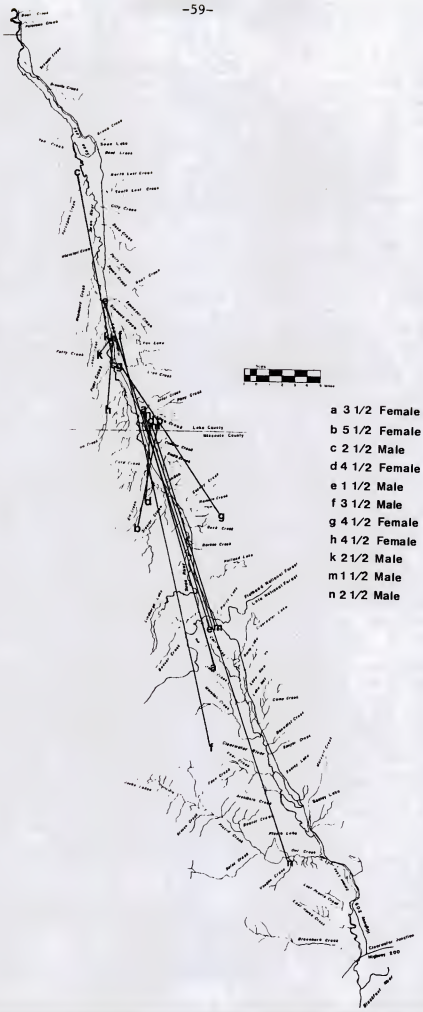


Figure 16. Recovery locations of 11 observation-collared deer during the 1979 hunting season.

lasiocarpa series, occurred. They were represented either by mixed, seral communities or dense stands of lodgepole pine. Habitat and cover types were not consistent between home ranges. Those parameters probably were less important than the mere presence of dense coniferous cover in seral communities.

Each radio-collared deer used a small activity center that was near a mesic site. The sites occurred as creek bottoms, marchy creek bottoms, potholes, marshes, and meadow. Habitat types, within the *Picea* series, often occurred in the mesic margins and spruce, in combination with other conifers, and occasionally cottonwood (*Populus trichocarpa*) dominated.

Certain summer home ranges also included recent clearcuts. The heaviest use of clearcuts apparently was confined to the edges, as few tracks of pellets were encountered elsewhere in clearcuts. Natural openings and wet sites, which had been isolated by logging, were not used.

Habitat diversity also characterized summer home ranges. Mesic sites were interspersed with uplands. Uplands were mosaics of habitat and cover types. The mosaics resulted from topographic variations and previous influences of fire. Only major trails were recognizable on summer range; they typically followed edges.

DISCUSSION

White-tailed deer in the Swan Valley occupy a diverse environment year-long. Timbered mesic sites and timbered uplands were integral habitat components. Interspersion best described the timbered margins of mesic sites, the timbered uplands, and the interrelationship between mesic areas and uplands. Topographic variation further contributed to habitat diversity.

White-tailed deer used timbered, riparian habitat for resting and security during all seasons, and especially during winter. Loveless (1967) suggested that mule deer move about within their winter habitat to seek the most comfortable temperature zones. Ozoga (1968) demonstrated microclimatic variation within the Petral Grade deeryard. In that area, mature swamp conifers provided the warmest average temperatures, the most stable microclimate, and snow conditions were the most amenable to travel. Moen (1968) demonstrated that under clear night skies, deer experienced greater radiant heat loss in an open field than under a cedar canopy. Drolet (1976) indicated that a dense forest of conifers and mixed woods provided more protection against adverse weather than open mixed and hardwood forest. Presumably, timbered, riparian habitat provided the most comfortable microclimate within the Swan Valley winter range.

Deer consistently used timbered uplands for foraging. During winter, the use of uplands, relative to the use of riparian habitat, was dispersed, and uplands comprised a comparatively large portion of individual home ranges. Prominent items in the winter diet were common species in the understory of timbered upland communities. Although those species were common, their availability was restricted by persistent snow cover. Therefore, individuals had to forage over a large area to obtain minimum rations.

White-tailed deer habitat in the Swan Valley also is relatively stable. The animals apparently are adapted to the mature, sub-climax forest. Fire has had

an important influence throughout the valley, and it has contributed both to diversity and stability.

Lightening-caused fire is a normal occurrence. Evidences of previous fires included the lack of climax communities; even-aged stands of lodgepole pine and dense thickets of Douglas fir, which resulted from hot fires; and, charcoal and fire scars on mature trees in mixed communities, which resulted from low-intensity, ground fires. Ground fires suppressed regeneration of all species, prevented establishment of fire-sensitive grand fir and sub-alpine fir, and favored fire-resistant Douglas fir, lodgepole pine, ponderosa pine, and western larch. Fire seems to have perpetuated the sub-climax condition more so than it initiated secondary succession. Thus, fire has had a stabilizing influence and a predictable combination of forage and cover has resulted. Within the grand fir forests of the Swan Valley, "a mosaic of various aged, fire indiced seral communities is the natural mode of the vegetation" (Antos 1977:203). Singer (1975) reported that most of his study area in the North Fork Flathead River was subjected to repeated fires. In that area, ground fires were characteristic in Douglas fir stands, crown fires were characteristic of other coniferous stands, and fire was largely excluded in wet spruce stands. Arno (1976) indicated that fires frequently occurred on the Bitterroot National Forest and that substantial amounts of forest survived most fires.

Weather is another aspect of environmental stability. Although weather is variable between years, that variation is less extreme than that observed on other deer study areas in Montana (Mackie 1970: Mackie et al. 1979). Summer conditions remain lush, even during comparatively dry years. Winter duration was similar each year of this study. Because of that similarity and the presence of a suitable winter range, deer were able to tolerate the relatively severe winters.

Mackie (1978) hypothesized that natural regulation in mule deer populations is effected by inherent habitat characteristics in relation to inherent requirements and attributes of the animals. He also indicated that high density mule deer populations characteristically occurred in complex, diverse, and stable habitats, and that high density populations were characterized by low and stable annual turnover and recruitment. These relationships also appear to describe the white-tailed deer population in the Swan Valley.

A population estimate was not developed during this study. However, densities were in the order of 10 deer/sq. mi. during summer and 100 deer/sq. mi. during winter.

Similar recruitment rates were determined each year and those also were similar to the rate determined in 1970 (Hildebrand 1971). Recruitment apparently was sufficient to replace annual attrition. Annual survival was approximately 70% for all animals 6-months and older. That value was complementary with annual recruitment, and those values, together, implied a stable population.

Male mortality was higher than that of females. Numbers of males declined rapidly through the first 4 years. Although observed male longevity was 11½-years, few males, older than 5-years, remained in the population.

Female mortality was lower and more uniform. Observed female longevity was 14½-years and approximately 30% of the female population was older than 5-years. Population stability was an important consequence of that female age-structure and the observed reproductive patterns.

Annual recruitment averaged 29.5% during this study, and that rate was maintained despite the loss of 60% of the potential fawn production. Certain aspects of that reproductive pattern were previously discussed (Mundinger 1979).

Production by 2 - 4-year-old does was low and variable. Successful does in that age-group produced single fawns, and those which were successful failed to rear a fawn in the subsequent year. The population retains the potential for rapid increases during favorable years because this age-group is numerically large. Yet, those increases probably are not a common occurrence, and should they happen, their effect would be dampened by reduced recruitment in the following year (Mundinger 1979). This age-group is the most responsive to poor recruitment years. Yet, the absolute number of fawns recruited during a poor year still could be substantial because of the size of this age-group.

Production by 5+-year-old does was higher and less variable. About one-fourth of the successful does reared twins, and alternative year production was less rigid for this age-group. While old does comprised about 30% of the female population, they produced more than half of the recruited fawns. Because production by old does was less variable, that portion of the annual increment was somewhat predictable, i.e. the absolute number of fawns produced by old does would be similar each year, irrespective of the suitability of the year for fawn production.

This population is stable and age-structure, survival, and recruitment function interdependantly to maintain that stability. The female age-structure is full and pyramid-shaped. That age-structure is resilient because survival of 6-month and older females is high and uniform. Recruitment is sufficient to replace annual attrition and the relationship between total fawn production and age-structure tends to determine a stable recruitment rate. Stable recruitment in association with high and uniform female survival reinforces the stable age-structure.

Variations in survival and recruitment among individual cohorts was observed during this study. It is likely that those variations were compensatory. For example, recruitment by 2½-year-old does was unusually high during 1979. That same year, recruitment by 3½- and 4½-year-old does was below average (Table 18). Moreover, the environment is relatively stable. Therefore, the normal range of variation in survival and recruitment probably is narrow.

The indicated population dynamics and habitat relationships of the Swan Valley white-tailed deer population have important management implications. These are related to the influence of hunting and habitat alteration.

The average annual harvest for Hunting District 130 was 630 deer during this study. A reliable population estimate could not be developed and the percentage of the population which was harvested was, therefore, not known. Futher, animals harvested in Hunting District 130 would have wintered either in the upper or lower Swan Valley, but the proportions of each was not known. Additional animals that would have wintered in the upper Swan were harvested in Hunting District 283 and thus not included in the average harvest.

Tag returns represented between 5% and 11% of the number of marked animals that were known to be in the population during each hunting season. Although those values were conservative estimates, they do suggest that present harvest

rates are considerably less than the annual increment. Further, the majority of the harvest came from the adult male segment of the population (Table 1). Therefore, it is unlikely that the present trend of this population is influenced by hunter harvests.

This population probably could support a larger harvest. That would require the harvest of additional antlerless animals. The simulated population (Table 29) could sustain a harvest of approximately 25% of the antlerless animals, if compensatory mortality is assumed. That also assumes that only "surplus" animals within each age-class were taken. An antlerless harvest of approximately 20% would compensate for hunter bias against fawns.

It is unlikely that a heavy antlerless harvest would stimulate increased fawn production. Adequate fawn production is dependant upon the female age-structure. Numbers of older females, which recruit a disproportionate number of fawns, would be reduced by heavy harvests. Even if production by younger does increased, that increase probably would not be sufficient to offset the loss.

Density of this population apparently is maintained through natural regulation. Present harvest levels function more to remove a portion of the annual surplus than to curtail population increases. There are no range problems associated with the stable density and herd reductions presently are not necessary for effective management of this population. Although the population could support a larger harvest, it would not be possible to determine when a proper harvest level was achieved without a reliable census method. Therefore, a moderate harvest strategy should be continued.

The Swan Valley white-tailed deer population is stable with respect to density. The total population is, therefore, determined by the amount of land area which is capable of producing deer at that density. This population apparently is best adapted to the mature, sub-climax forest. That condition should produce the greatest number of deer through the longest period of time.

It is probable that modified habitats either would continue to produce deer at a rate similar to the stable density or they would produce no deer. An ecologically younger forest possibly could produce deer at a higher density, however, that increase would be of short duration. Moreover, it is unlikely that the habitat could be manipulated to produce deer at a higher density, unless it first remained out of deer production for an extended period. Thus, the loss of habitat, either summer or winter range, is equivalent to the loss of deer because there is no opportunity to produce those animals elsewhere. While that loss may involve only a few deer, it is a substantial loss when considered over the length of time during which those animals are not produced.

Timber production is the dominant land use and logging has impacted extensive areas in the Swan Valley. Logged areas are essentially unused by deer during winter. During snow-free periods, deer use of logged areas largely is confined to the margins. Logging probably has stimulated increased production of shrubs and herbaceous plants. In many cases these are species other than those associated with the forest understory and either do not occur or are less important in the winter diet. Forage plants in clearcuts are unavailable to deer during winter. Their availability during spring-summer-fall is related to the proximity of uncut forest or the presense of dense regeneration in the cut. In many large clearcuts, regeneration is proceeding slowly and the central portions are unavailable to deer.

The influence of timber management on white-tailed deer may be inferred from their distribution and habitat relationships. Deer occupy small seasonal home ranges. Those are mosaics of essential habitat components, mesic sites and mature, sub-climax forests. Previous timber sales have reduced the total area of deer habitat. This has occurred because cover was removed, habitat integrity and diversity were disrupted, and logging units were large in comparison with average home range size. Specific examples of detrimental practices included: 1) logging units defined by property lines rather than by ecological boundaries, such that a uniform prescription included a diversity of habitat/cover types; 2) logging units which isolated important topographic features, e.g. mesic sites, and ridge and draw complexes; and 3) large clearcuts.

Logging also may have reduced production and availability of winter forage. Upland clearcuts, which prior to logging were used for foraging, no longer are available during winter, perhaps due to increased snow accumulation (Hildebrand 1971). Low-growing, evergreen species were common in the forest understory and, collectively, were important in the winter diet of deer. Those species may be less abundant in clearcuts. In southeast Alaska, uneven-aged old-growth forests provided the most available winter forage for Sitka black-tailed deer (*O. h. sitkensis*)(Schoen and Wallmo 1979). Those stands had substantially greater understory, larger and more robust *Vaccinium*, and abundant evergreen herbaceous species. Arboreal lichens also were consistently used, but the importance of this material could not be determined by standard food habits analysis. The major source of lichens was litterfall from mature larch trees, an important commercial species. Arboreal lichens comprised 35% of the winter diet of black-tailed deer (*O. h. columbianus*) on northern Vancouver Island (Bunnell 1979). There, lichen litterfall was approximately equal to the production of rooted forage and its dry matter digestibility was 35-40% higher than that of the rooted species. Labratory analysis indicated that arboreal lichens contained 6% crude proteins (Montana Department of Fish, Wildlife and Parks files). This material also may have synergistic relationships with other forage items.

It is likely that white-tailed deer habitat will continue to be lost to logging. Present timber management plans include a 120-year, or shorter, rotation. Thus, logging of mature, sub-climax forest will continue and the second growth forest will be cut again before plant succession has progressed to the condition to which white-tailed deer are best adapted. Similarly, Schoen and Wallmo (1979) indicated that sustained yield timber management on a 100-year rotation would impair Sitka black-tailed deer habitat in southeast Alaska forever.

Habitat manipulation, as presently practiced, has been detrimental to white-tailed deer. Yet, the sub-climax forest is an ephemeral condition, and in the absence of natural fire, manipulation is necessary to perpetuate deer habitat. Effective management is that which would maintain the sub-climax condition without compromising the land's capability to produce deer. Present sylviculture is not consistent with that objective.

RECOMMENDATIONS

Timber Management

Logging has impacted extensive areas in the Swan Valley and throughout northwestern Montana. The net effect of that impact has been detrimental to white-

tailed deer. Until deer reoccupy recently logged areas, timber management should be designed to minimize detrimental influences within presently occupied deer habitat.

This study has not evaluated specific sylvicultural prescriptions and their influence on white-tailed deer. However, certain detrimental practices were obvious and reasonable alternatives to those practices could be inferred from the observed deer range use patterns.

On summer range, the integrity of mesic sites and the associated mature forest must be maintained. Thermal cover in riparian habitat is essential. Withdrawal of those areas from treatment is preferred. Logging in riparian areas may be acceptable if it is restricted to a very light selection for sanitation/salvage.

Riparian habitat also must be contiguous with larger units of thermal and hiding cover in upland habitat. A variety of logging techniques may be appropriate on summer range uplands. The primary consideration should be the maintenance of interspersion and diversity. Therefore, logging units should be contained within ecological boundaries, clearcuts should be less than 20 acres, and leave areas should be unit-sized or larger. Following treatment, the total area of mature forest should equal or exceed that of the logged area.

The winter range should be designated for special management and withdrawn from the regulated timber harvest. The harvest rotation on the winter range should be extended to 250 years.

The integrity of both riparian areas and upland foraging areas must be maintained on winter range. Thermal cover is an essential component in both habitats. Riparian areas should be withdrawn from treatment, although a very light selection may be tolerable.

Winter range uplands should be managed to perpetuate communities with mixed species in multiple age-classes. Logging should employ selection/group selection within units of less than 20 acres or clearcuts of less than 5 acres. Units should be contained within ecological boundaries. Selection should not reduce the overstory below 70% crown closure.

On all seasonal ranges, sale proposals should be evaluated on an individual basis. Modifications may be necessary to accomodate site specific characteristics or previous logging.

Logging constraints for white-tailed deer should be compatable with the habitat requirements of elk. The reverse may not be true. Therefore, where the species are sympatric, consideration for deer should have precedence.

Deer Management

A reliable census method for deer in the coniferous forests of northwestern Montana has not been developed. However, estimates of several other population parameters, considered together, may be sufficient to assess population status and trend.

Trend counts were not sensitive to minor, annual fluctuations, although they may have indicated large changes, had they occurred. This technique did have value, because it was an easily collected sample that provided a reliable estimate of the annual recruitment rate. That parameter should be determined for populations in each of the major wintering areas in northwestern Montana, either from trend counts or other observations, systematically collected throughout the winter.

Hunter questionnaires and checking station data together were a rough estimate of population trend; neither, by itself, was adequate. A complete count of the harvest would have been preferrable. That count should include information on harvest distribution and sex/age. Survival may be determined from the age data.

Large samples of marked animals had value for determining distribution and for assessing recruitment, survival, and harvest rates. Additional animals should be marked for study on other important wintering areas. Those samples should include animals equipped with telemetry transmitters in order to define important summer habitats.

Logging and sub-divisions have impacted substantial areas of white-tailed deer habitat throughout northwestern Montana. Important habitats, both winter and summer range, should be delineated and the extent of conflicting land use within each assessed.

Future Research

The proposed timber management guidelines are tentative. Additional work should be directed toward the development of a schedule of habitat manipulations which are consistent with the habitat requirements of white-tailed deer. Presently, it is not possible to accomplish this objective by evaluating previous logging units, because intensive timber management is a recent phenomenon and a variety of sylvicultural prescriptions in a spectrum of age-classes is not available for study. A preferable alternative would be to test the hypothesis that the historical role of fire in the Swan Valley ecosystem is a model for future timber management that would effectively perpetuate habitat for white-tailed deer.

It is postulated that logging has effected a reduction in forage production and availability. Thus, the winter nutritional relationships of deer should be clarified and the potential for this influence assessed.

There are three white-tailed deer population segments associated with the Swan and Clearwater drainages. This study has considered that segment which winters in the upper Swan Valley, while Janke (1977) and Slott (1979) worked with that segment which winters at Salmon Lake. Characteristics of those winter ranges differed. Differences in winter range relationships and population dynamics also were evident. The upper Swan segment was characterized by higher adult survival and lower recruitment. Yet, the summer distribution of those segments overlapped. The third segment winters in the lower Swan Valley. Present distribution, habitat relationships, and population dynamics of that segment largely are unknown. Clarification of the lower Swan segment would provide information concerning the variability among white-tailed deer populations in the

coniferous forests of northwestern Montana and would provide a foundation for more effective deer management in Hunting Districts 130 and 283.

The summer habitat requirements of white-tailed deer in the coniferous forest had been difficult to evaluate prior to the development of reliable telemetry equipment. Preliminary findings indicate that suitable summer range is as essential to the welfare of this population as suitable winter range, but that a greater variety of environmental situations can satisfy minimum summer range requirements. Therefore, the evaluation of summer habitat requirements should be intensified.

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Appendix Table 1. Plant nomenclatures used in food habits tables.

Abbreviation	Nomenclature	Common Name
Conifers		
ABGR	*Abies grandis*	Grand fir
JUCO	*Juniperis communis*	Common juniper
LAOC	*Larix occidentalis*	Western larch
PISP	*Picea* spp.	Spruce
PICO	*Pinus contorta*	Lodgepole pine
PIPO	*Pinus ponderosa*	Ponderosa pine
PSME	*Pseudotsuga menziesii*	Douglas fir
THPL	*Thuja plicata*	Western red cedar
Shrubs		
ACGL	*Acer glabrum*	Mountain maple
ALIN	*Alnus incana*	Thinleaf alder
AMAL	*Amelanchier alnifolia*	Western serviceberry
ARUV	*Arctostaphylos uva-ursi*	Kinikinnik
BERE	*Berberis repens*	Oregon grape
BESP	*Betula* spp.	Birch
CESA	*Ceanothus sanguineus*	Redstem ceanothus
CEVE	*Ceanothus velutinus*	Snowbrush ceanothus
COST	*Cornus stolonifera*	Red dogwood
HODI	*Holodiscus discolor*	Mountain spray
PAMY	*Pachistima myrsinites*	Myrtle pachistima
POSP	*Populus* spp.	Cottonwood
RHAL	*Rhamnus alnifolia*	Alder buckthorn
ROSP	*Rosa* spp.	Rose
RUPA	*Rubus parviflorus*	Thimbleberry
SASP	*Salix* spp.	Willow
SHCA	*Shepherdia canadensis*	Cadadian buffalo-berry
SPBE	*Spiraea betulifolia*	White spiraea
SYSL	*Symphoricarpos albus*	Common snowberry
VASP	*Vaccinuim* spp.	Huckleberry
Forbs		
ADBI	*Adenocaulon bicolor*	Trail-plant
ANSP	*Antennaria* spp.	Pussytoes
CHUM	*Chimaphila umbellata*	Common pipsissewa
CISP	*Cirsium* spp.	Thistle
COCA	*Cornus canadensis*	Bunchberry dogwood
ERGR	*Erythronium grandiflorum*	Dogtooth lily
GOOB	*Goodyera oblongiflora*	Rattlesnake plantain
FRVI	*Fragaria virginiana*	Strawberry
HASP	*Hackelia* spp.	Stickseed
LIBO	*Linnaea borealis*	Twin-flower
PESP	*Penstemon* spp.	Penstemon
PLMA	*Plantago major*	Broad leaf plantain
PYSP	*Pyrola* spp.	Pinedrops
THOC	*Thalictrum occidentale*	Meadow rue
TRSP	*Trifolium* spp.	Clover
XETE	*Xerophyllum tenax*	Beargrass

Appendix Table 1. Continued.

Others		
ALSP	*Allectoria* spp.	Tree-moss
EQSP	*Equisetum* spp.	Horsetail

Appendix Table 2. Fall food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(1)[1] Percent	Frequency	1977(6) Percent
ABGR		0.17	tr[2]
JUCO		0.17	0.4
LAOC	0.5		
PICO		0.67	0.4
PIPO		0.17	0.1
PSME	0.1	0.50	4.6
Total Conifer	0.6	0.83	5.5
ACGL	tr		
AMAL	tr	0.50	4.2
BERE	68.8	0.83	29.3
BESP		0.17	0.5
CEVE	7.7		
PAMY	1.0		
RHAL	0.1		
RUPA		0.17	0.1
SASP		0.50	0.2
SYAL	tr	0.50	10.2
Unid. Browse		0.33	13.8
Total Browse	77.6	1.00	58.3
Conifer & Browse	78.2	1.00	63.7
ADBI	tr		
CISP	1.4		
COCA		0.50	11.4
FRVI		0.33	0.5
LIBO	6.8	0.33	0.5
PESP	0.7		
XETE	0.5		
Unid. Forbs	0.9	0.83	2.1
Total Forbs	10.3	0.83	14.6

Appendix Table 2. Continued.

Grasses		0.67	1.5
ALSP	9.0		
Larch Bark	1.4	0.33	0.1
Hay		0.17	14.6
Dry Leaves		0.33	0.8
Moss		0.17	tr
Mushroom	tr	0.50	4.3
Seeds	tr	0.33	1.1

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 3. December food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1975(3)[1] Frequency	1975(3)[1] Percent	1976(3) Frequency	1976(3) Percent	1977(4) Frequency	1977(4) Percent
ABGR			0.33	0.8		
JUCO	1.00	20.4	0.67	2.9	0.50	28.2
PISP					0.25	1.7
PICO	0.67	0.4			1.00	5.7
PSME	1.00	8.5	0.67	7.7	1.00	43.4
Total Conifer	1.00	29.3	1.00	11.4	1.00	79.0
ACGL	0.67	2.1	0.33	0.2		
ALIN	0.67	tr[2]				
AMAL	0.67	1.7	0.67	0.3	1.00	4.6
ARUV	1.00	4.4			0.25	1.1
BERE	1.00	27.1	1.00	43.0	0.75	0.4
BESP					0.25	0.1
CESA	0.33	tr				
CEVE	1.00	1.7	1.00	2.1	0.50	2.0
HODI			0.33	32.0		
POSP	0.33	0.5				
ROSP	0.33	tr			0.50	tr
SASP	1.00	7.9				
SPBE	1.00	0.7				
SYAL	0.33	0.4				
Unid. Browse	1.00	7.9	0.33	0.3	0.75	9.4
Total Browse	1.00	54.4	1.00	77.8	1.00	17.5
Conifer & Browse	1.00	83.7	1.00	89.2	1.00	96.4
ADBI			0.33	0.2		
ANSP	0.33	tr				
CHUM	0.33	0.1	0.33	2.3		
CISP			0.67	4.8		
GOOB	0.33	2.1				
LIBO	0.33	tr				
XETE	0.67	2.2	0.33	2.2		
Unid. Forbs	1.00	0.9	0.67	0.3	0.25	1.3

Appendix Table 3. Continued.

Total Forbs	1.00	5.3	1.00	9.7	0.25	1.3
Grasses	0.67	9.6			0.50	0.8
ALSP	0.33	0.3			0.25	0.4
Larch Bark	0.67	0.2	1.00	1.1	0.50	0.5
EQSP	0.33	0.1				
Dry Leaves					1.00	0.7
Mushroom	0.33	0.8				

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 4. January food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(3)[1] fre-quency	1976(3)[1] per-cent	1977(1) per-cent	1978(13) fre-quency	1978(13) per cent	1979(2) fre-quency	1979(2) per cent
ABGR				0.08	0.2	0.50	10.1
JUCO	1.00	28.5		0.15	0.1		
LAOC	0.33	1.7					
PISP				0.46	5.4	0.50	2.7
PICO	1.00	2.0		0.85	3.6	1.00	45.4
PIPO	0.67	0.6					
PSME	1.00	10.2	11.8	1.0	54.8	1.00	19.8
THPL				0.08	6.4	0.50	0.1
Total Conifer	1.00	43.0	11.8	1.00	71.1	1.00	78.0
ACGL			0.3				
ALIN	0.67	tr[2]					
AMAL	1.00	3.2	0.5	0.54	1.4	1.00	2.0
ARUV	1.00	6.9				0.50	tr
BERE	1.00	6.7	6.1				
CESA	0.67	3.5					
CEVE	0.67	2.6		0.46	1.9		
COST				0.08	0.3	0.50	0.5
POSP	0.33	0.1	tr				
ROSP	0.33	0.1	1.4			0.50	0.1
SASP				0.23	1.4		
SHCA	0.33	0.1				0.50	0.5
SPBE	0.33	1.6					
SYAL	0.33	tr	tr			0.50	0.1
Unid. browse	1.00	24.8	72.0	0.54	9.4	0.50	8.5
Total Browse	1.00	49.5	80.3	0.85	14.6	1.00	12.7
Conifer & Browse	1.00	92.5	92.1	1.00	85.7	1.00	90.7
CISP			5.3				
XETE			1.5				
Unid. forbs	1.00	2.2					
Total forbs	1.00	2.2	6.8				
Grasses				0.15	0.2		
AGSP	0.67	3.2		0.23	0.3	0.50	5.3

Appendix Table 4. Continued.

Larch Bark	0.67	1.3	0.4	0.46	0.7	0.50	3.6
Dry Leaves				0.23	0.1	0.50	0.5
Hay				0.15	12.8		
Lichen				0.23	0.1	0.50	tr
Moss	0.33	tr					
Mushroom	0.67	0.8	0.7				

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 5. February food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(4)[1]		1977(10)		1978(16)		1979(10)	
	frequency	percent	frequency	percent	frequency	percent	frequency	percent
ABGR	0.25	1.9						
JUCO	0.75	5.2	0.40	0.5			0.20	tr[2]
LAOC			0.10	0.1	0.13	1.1	0.30	tr
PISP					0.56	10.1	0.70	10.5
PICO	0.75	0.4	0.50	0.9	0.81	4.9	0.80	25.0
PSME	0.75	1.9	0.90	29.3	1.00	64.3	1.00	39.7
THLP	0.25	17.3					0.10	tr
Total Conifer	1.00	26.5	1.00	30.8	1.00	80.5	1.00	75.2
ACGL			0.10	0.1				
ALIN	0.50	0.2	0.10	tr				
AMAL	0.50	2.7	0.70	3.8	0.56	1.3	0.20	tr
ARUV	0.75	2.5	0.60	3.3				
BERE	1.00	22.5	0.90	37.7			0.10	tr
BESP	0.25	0.5	0.50	0.2				
CEVE	0.75	1.7	0.70	1.5	0.19	0.1	0.10	tr
COST			0.20	0.4			0.20	3.8
PAMY	0.25	tr	0.10	tr				
POSP			0.20	1.1				
RHAL					0.13	tr		
ROSP			0.40	1.4	0.19	0.2		
SASP	0.50	1.1	0.20	0.3	0.19	0.2	0.10	1.6
SHCA	0.25	0.2						
SPBE	0.75	0.8	0.40	0.3				
SYAL			0.10	0.7			0.10	0.4
Unid. Browse	0.75	27.8	0.80	14.6	0.31	5.6	0.30	11.3
Total Browse	1.00	60.0	1.00	65.0	0.75	7.6	0.70	17.2
Conifer & Browse	1.00	86.6	1.00	95.7	1.00	88.1	1.00	92.4
CHUM	0.50	0.6	0.20	0.2				
CISP			0.20	tr				
HASP					0.06	1.3		

Appendix Table 5. Continued.

LIBO	0.25	0.3	0.30	1.9				
XETE	0.75	1.1	0.20	0.5				
Unid. Forbs	0.25	2.5	0.40	0.4	0.06	tr		
Total Forbs	1.00	4.5	1.00	3.1	0.13	1.7		
Grasses	0.25	tr	0.10	0.4	0.25	0.1		
ALSP					0.31	4.7	0.70	3.6
Larch Bark	0.50	6.5	0.40	0.3	0.63	1.4	0.10	tr
EQSP			0.10	tr				
Dry Leaves					0.31	0.2	0.10	0.1
Hay					0.31	4.0	0.50	1.5
Lichen	0.25	tr	0.20	0.1	0.19	tr	0.50	0.5
Moss	0.50	2.6			0.06	tr		
Mushroom			0.20	0.1	0.13	0.2	0.20	tr

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 6. March food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(6)[1]		1977(12)		1978(14)		1979(5)	
	fre-quency	per-cent	fre-quency	per-cent	fre-quency	per-cent	fre-quency	per-cent
JUCO	0.50	1.8	0.42	1.0	0.21	0.4	0.20	1.1
LAOC			0.17	0.1	0.07	0.1		
PISP			0.08	0.1	0.14	4.6	0.60	14.0
PICO	0.67	1.3	0.67	3.0	0.93	8.0	0.40	4.0
PSME	1.00	3.8	0.92	9.0	1.00	57.8	1.00	17.7
THPL	0.17	0.7	0.08	tr[2]			0.20	1.1
Total Conifer	1.00	7.7	1.00	13.1	1.00	70.9	1.00	37.9
ACGL	0.17	tr	0.08	tr				
ALIN	0.83	0.4						
AMAL	0.67	0.6	0.42	0.4	0.43	0.9	0.60	0.4
ARUV	0.33	3.8	0.83	2.9	0.71	1.4	0.60	1.2
BERE	1.00	80.6	0.92	53.3	0.64	21.2	0.80	47.7
BESP			0.17	tr	0.29	0.1		
CEVE	0.67	0.7	0.33	1.2	0.29	0.3		
COST			0.08	0.1			0.20	0.7
PAMY	0.33	0.6						
POSP			0.17	0.2				
ROSP	0.17	tr	0.08	tr				
SASP	0.83	0.7	0.33	0.3	0.14	tr	0.20	0.3
SHCA					0.07	tr		
SPBE	0.50	0.2	0.33	0.2				
SYAL					0.07	tr		
Unid. Browse	0.67	1.9	0.83	4.6	0.57	1.9	0.80	3.2
Total Browse	1.00	89.3	1.00	63.0	1.00	25.8	0.80	53.3
Conifer & Browse	1.00	96.9	1.00	76.1	1.00	96.7	1.00	91.2
ANSP							0.20	0.1
CHUM	0.17	0.1	0.50	1.2	0.07	tr		
CISP							0.20	tr
FRVI	0.17	0.1			0.07	tr	0.40	tr
LIBO	0.50	0.4	0.75	9.7	0.14	0.1	0.60	3.4
PYSP			0.17	0.1				

Appendix Table 6. Continued.

THOC					0.07	tr		
TRSP			0.17	tr	0.14	0.1	0.20	tr
XETE	0.86	1.8	0.25	1.4			0.10	2.1
Unid. Forbs	0.17	0.2	0.33	0.9	0.21	tr		
Total Forbs	1.00	2.5	1.00	13.3	0.29	0.5	0.60	5.8
Grasses	0.33	0.1	0.67	6.8	0.57	1.7	0.20	0.3
ALSP	0.17	tr	0.25	2.0	0.14	0.1		
Larch Bark	0.17	0.2	0.50	1.3	0.29	0.1	0.60	0.8
EQSP	0.17	tr	0.08	tr				
Dry Leaves			0.33	0.4	0.50	0.3	0.40	0.4
Hay					0.29	0.7	0.40	0.4
Lichen					0.07	tr		
Moss	0.17	0.1					0.40	tr
Mushroom	0.33	0.2	0.08	0.1	0.29	0.1	0.20	0.8

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 7. Winter food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(16)[1]		1977(26)		1978(47)		1979(17)	
	fre-quency	per-cent	fre-quency	per-cent	fre-quency	per cent	fre-quency	per-cent
ABGR	0.06	0.5	0.04	0.1	0.02	0.1	0.06	1.2
JUCO	0.75	11.1	0.42	1.0	0.15	2.6	0.18	0.3
LAOC	0.06	0.3	0.12	0.1	0.06	0.4	0.18	tr
PISP			0.04	tr	0.38	6.4	0.65	10.6
PICO	0.75	1.0	0.50	1.7	0.87	5.5	0.71	21.2
PIPO	0.13	0.1					0.06	tr[2]
PSME	0.94	5.4	0.88	16.7	1.00	58.0	1.00	30.9
THPL	0.13	4.6	0.04	tr	0.02	1.8	0.18	0.3
Total Conifer	1.00	23.1	1.00	19.7	1.00	74.9	1.00	64.6
ACGL	0.19	0.4	0.15	0.1				
ALIN	0.69	0.2	0.04	tr				
AMAL	0.69	1.8	0.58	1.7	0.55	1.5	0.41	0.4
ARUV	0.69	4.1	0.62	2.6	0.23	0.5	0.24	0.3
BERE	1.00	42.2	0.92	44.3	0.26	6.3	0.29	14.0
BESP	0.06	0.1	0.27	0.1	0.11	tr		
CESA	0.06	tr						
CEVE	0.69	1.5	0.54	1.4	0.32	0.9	0.06	tr
COST			0.12	0.2	0.02	0.1	0.24	2.5
HODI			0.04	3.7				
PAMY	0.19	0.2	0.04	tr				
POSP	0.13	0.1	0.19	0.5				
RHAL					0.04	tr		
ROSP	0.19	tr	0.23	0.5	0.11	0.1	0.06	tr
SASP	0.63	2.0	0.23	0.2	0.17	0.5	0.18	1.0
SHCA	0.13	0.1			0.02	tr	0.06	tr
SPBE	0.63	0.7	0.31	0.2				
SYAL	0.13	0.1	0.08	0.3	0.02	tr	0.12	0.3
Unid. Browse	0.83	13.8	0.77	10.6	0.53	5.9	0.47	8.6
Total Browse	1.00	68.0	1.00	66.1	0.87	15.8	0.76	27.3
Conifer & Browse	1.00	91.0	1.00	85.8	1.00	90.7	1.00	91.9

Appendix Table 7. Continued.

ADBI			0.04	tr				
ANSP	0.06	tr					0.06	tr
CHUM	0.25	0.2	0.35	0.9	0.02	tr		
CISP			0.19	0.8	0.02	tr	0.06	tr
FRVI	0.06	tr			0.02	tr	0.06	tr
GOOB	0.06	0.4						
HASP					0.02	0.5		
LIBO	0.31	0.2	0.46	5.2	0.04	tr	0.18	1.0
PYSP			0.08	tr				
THOC					0.02	tr		
TRSP			0.08	tr	0.04	tr	0.06	tr
XETE	0.63	1.4	0.27	1.1			0.12	1.6
Unid. Forbs	0.44	1.3	0.38	0.6	0.11	0.1		
Total Forbs	1.00	3.5	1.00	8.7	0.13	0.5	0.24	2.7
Grasses	0.31	1.8	0.35	3.3	0.34	0.7	0.12	0.1
ALSP	0.25	0.7	0.12	0.9	0.23	1.7	0.47	2.7
Larsh Bark	0.44	2.0	0.54	0.8	0.47	0.8	0.24	0.6
EQSP	0.13	tr	0.08	tr				
Dry Leaves			0.15	0.2	0.32	0.2	0.24	0.2
Hay					0.23	5.1	0.41	1.0
Lichens	0.06	tr	0.08	tr	0.13	0.1	0.35	0.3
Moss	0.25	0.7			0.02	tr	0.12	tr
Mushroom	0.19	0.2	0.15	0.1	0.13	0.1	0.18	0.3

[1] Sample size in parentheses.

[2] tr = trace, less than 0.1 percent.

Appendix Table 8. April food habits of white-tailed deer in the upper Swan Valley, as determined by rumen analyses.

Taxon	1976(3)[1] Frequency	1976(3)[1] Percent	1977(4) Frequency	1977(4) Percent	1979(1) Percent
JUCO			0.50	4.3	
LAOC			0.25	1.3	
PICO	0.67	1.0	0.75	0.9	21.7
PSME	1.00	19.4	0.50	tr	60.9
Total Conifer	1.00	20.4	1.00	6.4	82.6
ACGL	0.33	0.4			
ALIN	1.00	0.7			
AMAL	1.00	5.3	0.50	0.1	
ARUV	0.67	2.0	0.75	4.0	12.7
BERE	1.00	37.8	1.00	76.5	
BESP			0.50	tr	
CESA			0.25	tr	
CEVE	1.00	0.9			
COST			0.25	tr	
PAMY	0.67	14.2	0.25	0.2	
SASP	0.33	0.4			
SPBE	0.33	tr			
Unid. Browse	0.67	7.0	0.25	0.6	1.2
Total Browse	1.00	68.7	1.00	81.3	13.9
Conifer & Browse	1.00	89.2	1.00	87.7	96.5
CHUM			0.25	0.1	
ERGR	0.67	0.2			
FRVI			0.25	0.1	
LIBO	0.33	0.3	0.75	8.9	1.5
PLMA	0.33	0.3			
TRSP			0.25	tr	
XETE	0.67	6.5			
Unid. Forbs	0.67	1.5	0.50	0.7	0.6
Total Forbs	1.00	8.7	1.00	9.7	2.1
Grasses	0.67	2.0			
ALSP					tr
Larch Bark					1.5

Appendix Table 8. Continued.

[1]Sample size in parentheses.
[2]tr = trace, less than 0.1 percent.

Appendix Table 9. Monthly classifications of white-tailed deer in the upper Swan River Valley during the winters, 1976-1979.

Year/ Month	Total	Adults	Fawns	Unclassified	ff/100 Ad.	% ff
1976						
January	188	110	44	34	40	28.6
February	518	335	150	33	45	30.9
March	1,458	1,002	376	80	38	27.3
April	105	72	30	3	42	29.4
1976 TOTAL	2,269	1,519	600	150	39.5	28.3
1977						
January	103	69	26	8	38	27.4
February	1,024	636	295	93	46	31.7
March	2,476	1,636	646	194	39	28.3
April	140	88	43	9	49	32.8
1977 TOTAL	3,743	2,429	1,010	304	42	29.4
1978						
December	152	91	48	13	53	34.5
January	648	405	196	47	48	32.6
February	2,089	1,366	656	67	48	32.4
March	1,240	798	376	66	47	32.0
April	69	47	19	3	40	28.8
1978 TOTAL	4,198	2,707	1,295	196	48	32.4
1979						
January	553	395	147	11	37	27.1
February	1,572	1,125	426	21	38	27.5
March	975	704	267	4	38	27.5
1979 TOTAL	3,100	2,224	840	36	38	27.4

Appendix Table 10. Summary of reproductive tract collections, 1976-1980.

Date	Age	C. L. of Pregnancy	Embryos	C-R Length	Weight
1976					
1/22	1½[1]	1	1		
3/10	1½	1	1♀	21.0	289.0
12/24/75	Adult	2	2		
12/24/75	Adult	2	pregnant		
1/17	Adult	2	1	5.0	5.0
			1	5.0	4.0
3/13	Adult	2	1♂	22.0	392.0
3/17	Adult	-	1♂	24.0	405.0
3/26	Adult	-	pregnant		
4/12	Adult	2	1♂	30.0	838.0
			1♀	29.0	805.0
4/22	Adult[1]	2	1♂	-	-
1977					
2/3	1½	1	1		
2/3	2½	2	2♂		
2/27	2½	2	1♂	18.0	142.0
			1♀	18.5	147.0
3/23	2½	-	1♂		
3/1	3½	1	1♂	17.0	
3/10	3½	-	1		
3/16	3½	2	1♂	23.0	363.0
			1♀	23.0	347.0
3/23	3½	2	1♂	24.0	443.0
			1♀	23.0	466.0
3/30	3½	2	1♀	27.0	746.0
			1♂	27.0	
4/6	3½	2	1♂		
			1♀		
4/15	3½		pregnant		
3/22	4½	2	1♂	22.0	336.0
			1♂	26.0	546.0
1/13	01d[1]	2	1		
2/26	01d	0	0		

Appendix Table 10. Continued.

Date	Age	C. L. of Pregnancy	Embryos	C-R Length	Weight
1978					
2/6	1½	2	1♂		
2/12	1½	2	1♀	11.1	36.9
			1♀	10.5	37.8
2/13	1½	1	1♀	14.7	81.8
3/1	1½	2	1♀	19.8	262.0
3/20	1½		1♂		
4/11	1½	2	1♀	23.8	477.0
			1♀	25.0	492.0
1/13	2½	2	1♂	7.3	11.8
			1♀		
1/17	2½	1	1♂	7.2	12.4
3/3	2½	2	1♂	18.0	238.0
			1♂	18.2	253.0
3/6	2½[2]	2	1♀		
3/30	2½		1♀		
			1 uncl.		
1/27	3½	2	2 uncl.		
2/10	3½	2	1♀	15.5	119.0
			1♀	15.7	116.2
3/6	3½	1	1♀	20.8	338.0
3/20	3½		2 uncl.		
3/23	3½	2	1♂	25.0	445.0
			1♂	23.7	423.0
3/23	3½	2	1♀	24.5	482.0
			1♂	24.2	460.0
1/5	4½		pregnant		
1/10	4½		pregnant		
1/19	4½		pregnant		
2/13	4½	2	1♂	12.0	53.9
			1♀	12.0	51.5
3/23	4½	2	1♂	25.7	465.0
			1♂	25.5	454.0
2/24	5½	2	1♂	19.8	253.0
			1♀	19.6	238.0
1/21	6½	2	pregnant		
3/3	7½	2	1♀	17.8	178.0
			1♂	18.2	202.0

Appendix Table 10. Continued.

Date	Age	C. L. of Pregnancy	Embryos	C-R Length	Weight
2/7	8½		pregnant		
3/13	8½	2	1♀	23.0	424.0
			1♂	24.0	520.0
1/21	10+	2	1♂	9.1	22.4
			1♂	9.0	26.2
3/10	10+	3	1♀	26.0	499.0
1979					
2/22	1½	1	1♂	16.3	123.0
2/23	1½	0	not pregnant		
3/22	1½	2	1♂	22.5	321.0
			1♀	21.1	285.0
1/23	2½		1 uncl.		
3/5	2½ [2]	2	1♀	23.2	378.0
1/20	3½	2	1♂	5.7	8.1
2/11	3½		2 uncl.		
3/9	3½	1	1♀	23.3	406.0
3/14	3½		1♀		
			1 uncl.		
4/6	3½	2	1 uncl.		
			1♂	31.3	1002.0
3/9	4½		pregnant		
2/22	5½	2	1♀	7.6	12.8
			1♂	7.6	12.6
2/25	5½		pregnant		
2/25	5½		pregnant		
2/26	6½	2	1♂	17.6	150.2
			1♂	17.7	155.6
3/5 [2]	6½		1♂		
2/24	11½	2	1♂	21.1	282.0
			1♂	20.5	272.0
2/8	12½	2	1♂	13.5	93.0
			1♂	13.8	102.0
1980					
3/5	1½		pregnant		
3/17	1½	1	1♀	23.6	421.0
4/7	1½	1	1♂	27.5	621.0

Appendix Table 10. Continued.

Date	Age	C. L. of Pregnancy	Embryos	C-R Length	Weight
1/21	2½	2	1♂	7.0	10.3
			1♂	7.3	11.3
2/7	2½	2	1♂		
			1♀	14.3	77.6
2/14	3½	2	1♂		121.5
			1♂	15.6	123.7
3/18[2]	3½		1♀		
3/12	Old	2	1♀	22.0	477.0
			1♀	23.7	519.0
4/1	Old	2	1♀	29.0	816.0

[1]Deer collected in the lower Swan Valley.
[2]Reproductive tract incomplete.

JOB TITLE: Factors affecting deer populations in coniferous forest habitat of western Montana (White-tailed deer movements, survival, and population characteristics in the Clearwater River drainage, Montana).

OBJECTIVES:

To determine and describe: Summer distribution of white-tailed deer which winter in the Salmon Lake area of the Clearwater drainage; the status, i.e., numbers and trend, fawn production and survival, and mortality factors affecting this deer population; seasonal food habits; winter range condition; and the potential effects of logging on deer habitats and population in the Clearwater River drainage.

FINDINGS:

Field work was completed during the spring of 1979 and the Final Thesis Report was submitted in December 1979 as a separate supplement to the 1978-79 Deer Studies Report for investigation on the population ecology and habitat relationships of white-tailed deer in the Clearwater River drainage, Montana. An abstract of the thesis by Barbara J. Slott is presented below.

ABSTRACT:

This study was conducted from December 1978 to September 1979 on white-tailed deer (*Odocoileus virginianus*) in the Salmon Lake area of western Montana. Total numbers, sex and age ratios, mortality, breeding season, and physiological condition were determined. Between 400 and 550 deer use the 7.4 square mile (19 km^2) winter range. Adult:fawn ratios for 1978 and 1979 were 100:48 and 100:51, respectively, indicating good fawn survival. The adult and yearling male: female ratio for 1979 was 23:100. Hunter harvest was the greatest mortality factor, but predation, auto-deer collisions, and malnutrition occurred. Conception dates ranged from 22 November to 6 December. Analyses of winter food habits indicated that coniferous and deciduous shrubs were most frequently used during severe winters. Throughout this area of winter deer concentration, the browse species were severely overutilized and fallen conifers were stripped of their needles in 48 hours. The summer ranges of six radio-collared deer were habitat-typed. Marked deer were sighted in the six major habitat types on the summer range: Douglas-fir/dwarf huckleberry, Douglas-fir/pinegrass, Douglas-fir/blue huckleberry, Douglas-fir/ snowberry, Subalpine fir/menziesia, and Subalpine fir/beargrass. Radio-collared deer and other marked deer seen in the summer migrated an average distance of 10.8 miles (17.4 km) from the winter range.

JOB TITLE Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana.

ABSTRACT

Studies to evaluate factors affecting populations of mule deer in the Bridger Mountains were continued during 1979-80. The winter of 1979-80 was slightly milder than the 9-year average (1971-1980). Total snowfall was greater than the 9-year mean, but the amount of accumulation was near average. Mean wind speed was similar during 1978-79 and 1979-80. Warmer temperatures during winter 1979-80 permitted earlier spring green-up than the previous year. Winter ranges on the east slope of the Bridger Range were characterized by more wind and less snow than west slope winter ranges, while temperatures were similar. Preliminary analysis indicate that the Armstrong and Brackett Creek winter ranges differ broadly in the vegetal, topographic and geological characteristics. A total of 44 cover types were recognized with a greater number occurring on the Brackett Creek winter range. Sagebrush cover was similar on both winter ranges, but the Brackett Creek winter range tends to be less forested, more impacted by human activities, is less rugged topographically and has a finer textural substrate. Winter deer distributions during 1979-80 were generally similar to previous years, although some minor changes were made in the location of winter range boundaries. Summer home range polygons averaged 0.65 mi^2 for 22 radio-collared females and 2.32 mi^2 for 8 males. Thirty individuals radio-collared on the Armstrong winter range had summer home ranges within 5 air miles of the winter range. The location and spatial relationships of summer herd ranges were delineated for deer associated with seven winter ranges. Population data for the Armstrong winter range indicated that 183 mule deer were present in early winter; the number decreasing to 160 by spring. Over-winter mortality was limited to a 32% loss of fawns. The spring fawn:female ratio of 46:100 was the highest since the study began. Proportions of adult females in the Armstrong population have declined while adult males have increased in the past two years. Approximately 63% of 79 marked adult females were 7.5 years or older while 94% of 16 marked adult males were 3.5 years of age or less. The relationship of sex-age structure to population phenomena during 1975-80 were discussed. An estimated 335 (67%) of 500 either-sex permit holders hunted deer in HD 312 and 136 killed deer. Hunting pressure and harvest were aggregated around several key access points. Calculations based on numbers observed within the Bridger complex and helicopter sampling efficiencies of 49% for west slope ranges and 51% for east slope ranges and south 16-Mile suggested that as many as 7,750 deer could have been present in late winter. Using known mortality rates for west and east slope populations, an estimated 8,350 deer were present in early winter.

JOB TITLE Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana.

JOB OBJECTIVE To determine the environmental requirements of mule deer and factors regulating mule deer populations in mountain foothill habitats of southwestern Montana.

To determine the effects of various potentially competing land use and management practices upon mule deer in southwestern Montana.

To develop new and improved guidelines for management of southwestern Montana mule deer populations and their habitats.

INTRODUCTION

This report describes and summarizes findings of studies on the population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana, for the period 1 July 1979 through 30 June 1980. These studies were initiated and have been conducted continuously since the winter of 1971-72 following two, broadly different approaches: (1) Intensive studies of the distribution, movements, range use and population characteristics of mule deer associated with specific winter ranges and (2) Extensive studies of the seasonal distribution, habitat relations and population characteristics of mule deer generally throughout the Bridger Mountain complex. The history and general nature of both efforts were described by Mackie et al. (1978).

In this report, emphasis is given to information obtained for mule deer associated with the primary study area, the Armstrong range; though data obtained generally and for other populations are included or presented comparatively where appropriate. Findings from intensive studies on Brackett Creek are reported separately as progress reports (Rosgaard 1980).

ACKNOWLEDGEMENTS

Studies of mule deer in the Bridger Mountains have been conducted with the cooperation and assistance of the Montana Department of Fish, Wildlife and Parks Region 3, and the U.S. Forest Service, Gallatin National Forest and Bozeman Ranger District. The willingness of numerous private landowners throughout the Bridger Range to allow access to their lands and in many cases their direct assistance in various aspects of the studies has been a major factor both in enabling the work to be done and in results achieved. Murray Duffy, Central Helicopters, Bozeman, and James Stradley, Gallatin Flying Service, Belgrade, both contributed extensively through their flying and observation skills in helicopter and fixed wing aerial surveys, respectively. Much credit is also due to all of the many individual Montana Department of Fish, Wildlife and Parks personnel and Montana State University graduate and undergraduate students who have participated in one way or another in the studies and without whose help much of the work could never have been accomplished. Willie Steerey provided extensive assistance in the data preparation phase for this report.

THE STUDY AREA

The Bridger Mountain Range (Fig. 1) is located in northeastern Gallatin and northwestern Park Counties, Montana. The total study area, encompassing the Bridger Range complex and adjacent foothills, prairie and agricultural lands used by or available to deer, includes a land area of approximately 800 square miles. It is bounded on the west by the East Gallatin River, Dry Creek and the Dry Creek-Maudlow road; on the north by 16-Mile Creek, its Middle Fork, and Cottonwood Creek; on the east by U.S. Highway 89 and the Shields River; and on the south by the Yellowstone River and Interstate Highway 90 between Livingston and Bozeman. A detailed description of the topographic and vegetal characteristics of the study area, including the size and location of major mule deer winter ranges was presented by Mackie et al. 1979.

METHODS

Habitat Description

Habitat parameters measured and general methodology employed were described by Mackie et al. (1978).

In addition, a comparison of environmental parameters between the Armstrong and Brackett Creek winter ranges was initiated. Parameters analyzed included: 1) areal coverage of each vegetation cover type, 2) areal coverage of plant communities based on growth form classification, 3) crown cover and size, 4) sagebrush canopy coverage, 5) steepness of topography, 6) aspect of steep slopes, 7) geological substrate, 8) physical accessibility, and 9) landowner restrictions on access. The technique used was to lay a numbered grid over the aerial photos, then to randomly choose a sample of the grid numbers and describe the above mentioned environmental attributes at each of the points. Use of the stereoscope facilitated the compartmentalization of topographic parameters into eight aspects and four slope declivity categories. A total of 765 points on the Brackett Creek winter range and 196 points on the Armstrong winter range were sampled. Sampling will continue until both summer and winter ranges for each area are described.

During 1979-80, emphasis was placed on 1) Obtaining basic weather data on five of the mule deer winter ranges to: a) document prevailing conditions, b) to compare and contrast conditions between years on each of the winter ranges, and c) to compare and contrast conditions between winter ranges and between the nearest U.S. Weather Service Stations, 2) continuing vegetation cover and habitat type delineation and mapping of major mule deer year-long ranges, 3) comparing and contrasting the Armstrong and Brackett Creek winter ranges on the basis of important environmental variables.

Population Studies

Various methods employed during the assessment of deer population characteristics have been previously described in detail by Mackie et al. (1978, 1979).

Early winter helicopter surveys (Mackie, Hamlin and Pac 1980) were conducted on 9-11 January 1980 on mule deer winter ranges along the west slope from Bridger Canyon to Pass Creek; North 16-Mile Creek; and Brackett Creek. During late winter, all major winter ranges in the Bridger complex were surveyed on 17-21 March 1980.

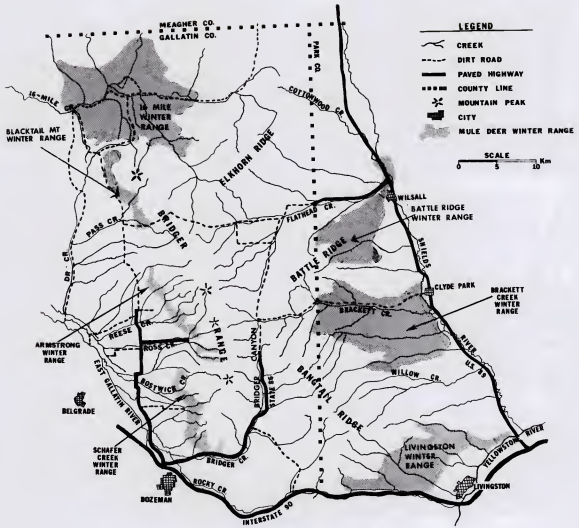

Figure 1. Map of the Bridger Range showing major features and the location of primary study areas.

Ground observations to develop late winter population estimates were recorded during a total of 8 days in April.

Additional marked deer in the Armstrong population were obtained by trapping between 18 January and 13 February, 1980. Thirty previously marked animals and 24 new deer were trapped. Three males and four females were radio collared and the remainder were neckbanded. A female fawn radio collared in early February was found dead later that month. Transmitters in operation on two adult does since April 1978, failed during fall 1979. A third doe, 7½+ years of age, wearing a transmitter collar attached in March 1979, died in late August. At the end of May 1980, fifteen deer wore functional transmitters. A summary of all mule deer tagged on the area from 1972 through 1980 and their status as of May 1980 is given in Table 1.

Table 1. Summary of mule deer trapped on the Armstrong winter range from 1972 through 1980 and their status as of May 1, 1980.

Year	Total No. Marked	No. OK[1] 6/80	No. Dead	Unknown[2]
1972	5	0	4 (3)[3]	1
1973	16	1	11 (1)	5
1974	39	9	13 (2)	17
1975	36	8	22 (9)	6
1976	9	4	3 (1)	2
1977	16	10	5 (2)	1
1978	42	23	11 (4)	8
1979	72	34	31 (1)[4]	7
1980	24	17	7 [5]	0

[1]Number alive during spring 1980. Includes five deer (3 females, 2 males) that wintered off the study area.
[2]Includes four deer known to have left AWR in past years and wintered elsewhere but were not observed in 1979-80.
[3]Number shot by hunters in parentheses.
[4]Includes 13 fawns not observed since early March and believed dead.
[5]Includes 1 fawn not observed since mid-March and believed dead.

Six deer (4 Ad♀♀, 1 Ad♂ , 1♂ Fawn) were trapped on the Brackett Creek winter range. Four were equipped with transmitter collars; the remainder were neckbanded. Three radio-collared females died during April and May. Thirteen individuals with functional transmitters were present in late May.

Four deer (3 Ad♀♀, 1 Ad♂) were radio-collared and six others (3 Ad♀♀, 2 Ad♂♂, 1♀ Fawn) were neck-banded in the vicinity of Sypes Canyon on the west slope of the Bridgers.

Movements data for radio-collared deer discussed in this report were analyzed with the Montana State University Sigma 7 computer using the TELDAY program.

Information on hunter success, hunter distribution, harvest size, sex-age structure and kill distribution were determined from a mail-out questionnaire sent to all 500 special either sex deer permit holders for HD 312.

RESULTS AND DISCUSSION

Habitat Description

Weather Conditions on major mule deer winter ranges

Overall, the winter of 1979-80 was considerably warmer than 1978-79; with higher temperatures prevailing on major winter ranges during all but the late winter (March-early April) period (Fig. 2). Temperatures were especially warm in early winter (November-December) and spring (late April-May).

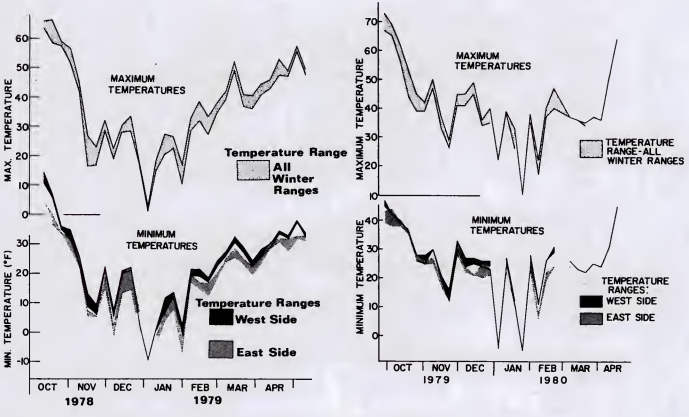

Figure 2. Trends in daily maximum and minimum temperatures on mule deer winter ranges in the Bridger Mountains, October 1978-April 1980.

Total snow depths (Figs. 3 and 4) and the percentages of ground completely covered by snow (Fig. 5) on winter ranges were also less in 1979-80 than the preceding year. Significant snow cover did not accumulate on any area until early January. Total snowfall, however, at least as recorded at the Bozeman-MSU weather station (Table 2), was greater in 1979-80 than the previous year. Thus, the lower snow depths and less complete coverage were due to periodic mild temperatures that prevented accumulation. Also, crusting of the snow cover was not severe during 1979-80.

Climatological data for the Bozeman-MSU weather station for winters 1971-72 through 1979-80 (Table 2) indicated that both total snowfall and the number of days with snow on the ground were greater than the 9-year average. However,

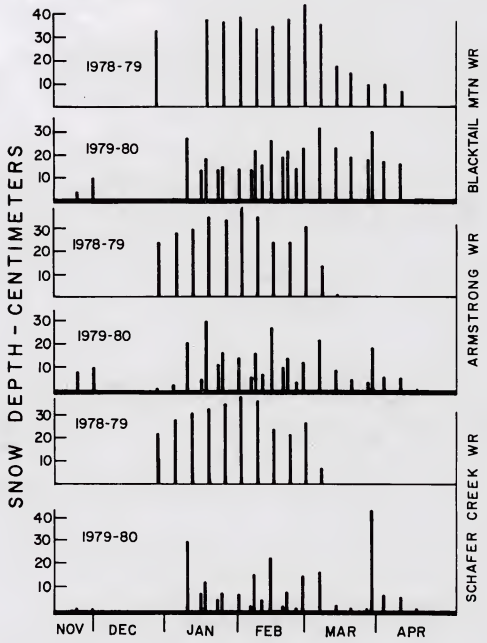

Figure 3. Snow depths on three mule deer winter ranges on the west slope of the Bridger Range, 1978-80.

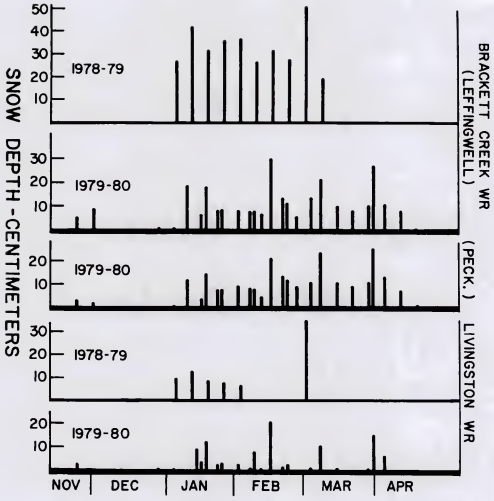

Figure 4. Snow depths on two mule deer winter ranges on the east slope of the Bridger Range, 1978-80.

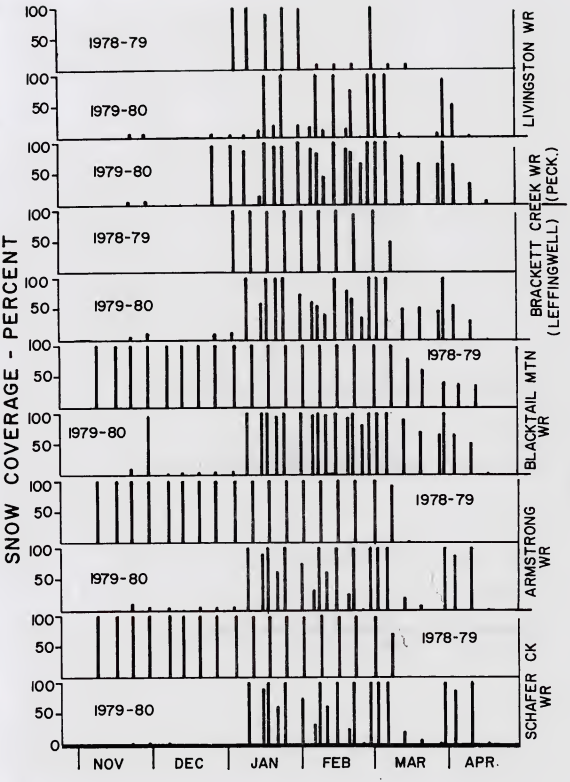

Figure 5. Percent of ground covered by snow on five mule deer winter ranges in the Bridger Mountains, 1978-80.

Table 2. Climatological data, MSU Weather Station, Bozeman, and severity indices, November through May, 1971-1980.

		Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity[1] Index
November	1971	33.7	0.77	11.2	5	17	- 297
	1972	32.8	0.63	3.0	4	8	- 250
	1973	30.4	1.27	15.8	11	25	+ 104
	1974	35.1	0.67	4.7	2	10	- 377
	1975	30.5	1.33	20.5	12	15	+ 491
	1976	35.5	0.20	3.9	4	4	- 415
	1977	31.7	1.19	12.0	8	11	+ 260
	1978	24.6	1.87	17.0	9	26	+ 955
	1979	24.0	0.96	15.4	11	15	+ 265
December	1971	20.8	0.56	11.1	10	31	+ 1161
	1972	18.6	0.49	12.2	4	23	+ 1047
	1973	29.5	1.29	20.5	13	16	+ 234
	1974	25.5	1.02	13.2	6	31	+ 284
	1975	30.0	1.10	15.8	6	22	+ 84
	1976	30.3	0.22	3.3	3	8	- 232
	1977	25.2	1.19	12.7	8	22	+ 315
	1978	16.8	0.72	13.9	10	31	+ 1954
	1979	32.7	0.30	7.7	8	24	- 237
January	1972	19.1	0.86	13.8	10	31	+ 1068
	1973	19.2	1.10	16.6	9	31	+ 1837
	1974	21.3	0.42	5.8	14	25	+ 3743
	1975	22.8	1.58	22.9	14	31	+ 1369
	1976	26.6	0.60	8.7	9	28	+ 360
	1977	30.3	0.60	13.5	9	31	+ 583
	1978	22.2	1.03	13.7	12	31	+ 842
	1979	6.9	1.03	15.5	16	31	+ 5597
	1980	17.2	1.17	21.1	14	31	+ 1503
February	1972	31.0	0.66	10.2	6	27	- 75
	1973	24.4	0.04	1.8	8	28	+ 483
	1974	32.0	0.43	7.8	4	21	- 206
	1975	21.3	1.11	19.5	17	28	+ 1659
	1976	30.4	0.52	9.8	4	5	- 187
	1977	33.8	0.06	1.0	3	17	- 322
	1978	26.3	0.87	15.1	11	28	+ 892

Table 2. Continued.

		Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity[1] Index
	1979	25.0	0.75	11.5	18	28	+ 1354
	1980	28.5	1.29	18.8	10	29	+ 479
March	1972	41.0	1.24	13.6	8	8	- 586
	1973	33.9	1.89	23.0	11	31	- 303
	1974	32.6	1.71	24.7	7	26	- 206
	1975	29.1	1.08	20.7	9	31	+ 295
	1976	28.7	1.03	18.5	6	12	+ 262
	1977	30.9	2.39	27.0	8	23	- 184
	1978	37.2	0.74	4.6	10	19	+ 59
	1979	33.0	0.77	10.1	14	31	- 125
	1980	30.7	1.67	33.8	20	31	+ 526
April	1972	41.3	1.91	21.9	4	5	- 652
	1973	38.9	2.84	34.7	14	14	- 520
	1974	45.8	1.87	3.2	0	0	- 764
	1975	32.9	1.77	16.1	8	24	- 141
	1976	43.4	3.35	21.9	4	4	- 663
	1977	48.1	0.57	5.7	8	4	- 875
	1978	44.9	0.93	1.4	trace	0	- 692
	1979	42.1	1.93	18.1	1	9	- 623
	1980	47.3	0.39	3.9	13	14	- 738
May	1972	50.7	1.73	trace	1	0	- 958
	1973	51.4	1.44	1.3	trace	0	- 989
	1974	48.3	3.00	12.1	3	3	- 880
	1975	46.9	4.88	21.5	9	6	- 803
	1976	55.5	1.95	trace	0	0	- 1157
	1977	50.3	3.84	3.4	0	1	- 946
	1978	49.7	4.04	1.0	0	0	- 886
	1979	60.7	3.66	1.3	0	3	- 1269
	1980	54.3	5.13	0	0	0	- 1046
Nov-May	1971-72	33.9	7.7	81.8	10	119	- 329
	1972-73	31.3	8.4	92.6	14	135	+ 1335
	1973-74	34.3	10.0	89.9	14	116	+ 2025
	1974-75	30.5	12.1	118.6	17	161	+ 2286
	1975-76	35.2	9.9	95.2	12	86	- 810
	1976-77	37.4	7.9	57.8	9	88	- 2391

Table 2. Continued.

	Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity[1] Index
1977-78	33.9	10.0	60.5	12	111	+ 790
1978-79	29.9	10.7	87.4	18	159	+ 7843
1979-80	33.3	10.9	100.7	20	144	+ 752
20 Year Average	32.4	9.5	82.7[2]	14[2]	124[2]	+ 1278[2]

[1] + Values indicate greater severity.
[2] 9-year average.

the average winter (November-May) temperature for 1979-80 was slightly above the long-term average. Winter Severity Indicies (Picton and Knight 1969) indicated that, overall, conditions in 1979-80 were only slightly less severe than average for preceding years.

Weather conditions on winter ranges along the east and west slopes of the Bridger Mountains are compared in Figures 2, 3 and 4, and Table 3. Trends in mean maximum and minimum temperatures averaged for weather stations on east and west side winter ranges for 1978-79 and 1979-80 are shown in Figure 2. Maximum daily temperatures varied only slightly between the east and west slope winter ranges both winters. Daily minimums were lower at east side stations during both seasons. The differences in minimum temperatures between east and west slopes was less clear in 1979-80, possibly due to continuing equipment malfunctions.

Mean monthly wind speeds, computed from total miles of wind recorded over weekly or occasionally longer periods for the five major winter ranges are presented in Table 3 . In both 1978-79 and 1979-80, wind speeds were consistently much higher east of the mountains than on the west slope. Wind speeds on the west slope winter ranges usually were lower in 1979-80 than the preceding winter, whereas the differences in wind speeds between years on the east side were inconsistent. No part of the winter seemed consistently windier than other parts during either winter.

Table 3. Mean wind speeds during nine time periods on five mule deer winter ranges in the Bridger Mountains, 1979 and 1980.

		PERIOD								
Station	Year	9/27-10/26	10/26-11/23	11/23-12/15	12/15-1/ 5	1/ 5-2/ 2	2/ 2-3/ 2	3/ 2-3/30	3/30-4/18	4/18-5/ 4
Schafer Creek WR	1979				2.19	0.84	1.58	1.51[1]	2.09	1.58
	1980	1.33	0.60	2.05	0.73	0.87	0.37	1.21	1.13	
Armstrong WR	1979				3.19	1.56	2.89	2.23	3.12	2.27
	1980	2.46	1.74	3.60	2.03	2.26	1.66	2.58	2.84	
Blacktail Mtn. WR	1979				3.42	2.06	2.52	2.50	3.15	2.29
	1980	2.82	2.03	3.58	1.94	2.55	2.03	2.93	2.76	
Brackett Creek WR-Leffingwell	1979				6.53	3.85	5.41	3.94	4.18	3.66
	1980	ND[3]	2.71[1]	6.38[2]	3.74	4.25	3.46	4.75	4.24	
Brackett Creek WR-Peckenpaugh	1979				8.54	4.27	6.76	5.14	6.92	6.72
	1980	4.87	3.88	9.01	4.23	ND[3]	4.50	7.06	6.05	
Livingston WR	1979				8.38	5.55	7.55	5.59	6.95	6.07
	1980	5.50	4.44[2]	9.09	6.78	ND[3]	5.21	7.38	6.15	

[1]From three weeks data
[2]From two weeks data
[3]ND = no data

During 1979-80, the percent of snow coverage and length of time with snow cover did not differ consistently between the west side and east side winter ranges as a whole. As in 1978-79, the area with the longest period of snow coverage during 1979-80 was the Blacktail Mountain winter range, where significant snow

cover persisted from late November into mid April. Snow persisted later at the Peckenpaugh station on the Brackett Creek winter range than at any other stations, but snow did not begin to accumulate there until late December. The shortest duration of snow cover during both winters occurred on the Livingston winter range, a reflection of consistently higher wind velocities and lighter snowfalls than other areas.

To compare conditions between winter ranges and long-established weather stations, data from local Weather Service Stations are shown with data from nearby winter ranges in Table 4. Like 1978-79, temperatures on the Schafer Creek winter range (southwest slope) were generally higher than those recorded at the MSU Station in Bozeman; while temperatures on the Livingston winter range were generally lower than those recorded at the Livingston Airport.

Table 4. Mean monthly temperatures (^{o}F) recorded on the Schafer Creek and Livingston winter ranges compared with monthly means and 30-year averages for U.S. Weather Service stations in Bozeman (MSU) and Livingston (airport).

		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
MSU	30 yr. ave.	32.3	25.1	20.8	26.2	29.9	41.9
	1978-79	24.5	16.8	4.7	24.9	33.0	42.1
	1979-80	23.0	32.7	17.2	28.3	30.7	47.3
Shafer Cr.	1978-79	26.8	17.4	11.2	26.9	34.5	40.3
Winter Range	1979-80	30.2	35.3	18.5	30.0	30.1	*
Livingston	30 yr. ave.	35.2	28.9	24.8	28.6	31.4	43.2
Airport	1978-79	27.3	17.4	*	27.3	*	*
	1979-80	32.8	35.5	*	*	*	*
Livingston	1978-79	25.0	17.1	9.3	23.2	32.2	39.8
Winter Range	1979-80	29.5	33.2	15.8	26.2	26.1	*

* Not available

Table 5 summarizes the phenology and development of common plants on the winter ranges and compares the phenology between years. Table 6 compares lilac phenology between years in Bozeman.

On all areas, plant growth and development did not begin in 1980 until about April 15, when the snow finally melted and temperatures became high enough for plant growth. This was slightly behind the onset of plant growth in 1979 (Table 5). Sharply increased and persistently high temperatures during the latter half of April led to accelerated phenological development through at least May 2 when monitoring ceased. By then development of many species was two weeks to a month ahead of that in 1979. In 1980, considerable quantities of new green forage became available on winter ranges shortly after mid-April. In 1979, comparable forage became available only gradually during May.

Table 5 . Phenology of important plants on mule deer winter ranges in the Bridger Range, 1979-80.

Livingston Winter Range (South Slopes)

SPECIES	YEAR	March 28-30	Mar-Apr 31-2	3-5	6-8	9-11	April 12-14	15-17	18-20	21-23	24-26	27-29	Apr-May 30-2	3-5	May 6-8	9-11
AGSP	1979	2(1)[1]			2(2)		2(2)		2(3)				3(6)	3(6)		3(6)
	1980					2(2)					3(6)		3(7)			
FEID	1979	2(2)			2(3)		2(3)		2(3)				3(6)	3(6)		3(6)
	1980															
KOMA	1979	2(1)			2(1)		2(1)		3(2)				3(2)	3(2)		3(2)
	1980					3(2)					3(3)		3(3)			
CHVI	1979	9			2		2		2				2	2		3
	1980					1					2		2			
ORHY	1979	9			9		2(1)		2(3)					3(7)		3(7)
	1980					2(1)					3(7)		3(8)			
AGSM	1979															3(8)
	1980				2(2)						2(4)		3(6)			
DEBI	1979						1							3-4		
	1980										4		4			
LEMO	1979													3		5
	1980					3(2)					3(5)		5			
LUAR	1979													2		2
	1980										2		4			
COUM	1979								2					3-4		3-4
	1980										3(1)		4			

Schafer Creek and Armstrong Winter Ranges

SPECIES	YEAR	March 28-30	Mar-Apr 31-2	3-5	6-8	9-11	April 12-14	15-17	18-20	21-23	24-26	27-29	Apr-May 30-2	3-5	May 6-8	9-11
AGSP	1979	2(2)			2(2)		2(3)		2(3)				3(5)	3(5)		3(7)
	1980							1	3(4)		3(6)		3(8)			
FEID	1979	2(2)			2(2)		2(3)		2(4)				3(6)	3(6)		3(6)
	1980							1	3(4)		3(4)		3(6)			
BASA	1979	9			9		9		9				1	1		2-4
	1980							9	1		4		4-5			
FRPU	1979	2(4)					4		4				5	5		5
	1980							9	3(4")		5		5			
DEBI	1979						1		9				2(2)	2(2)		3-4
	1980							9	2		4		4-5			
ROWO	1979												2	2		2
	1980							9	9		2		3			

Table 5. Continued.

Schafer Creek and Armstrong Winter Ranges (Con't)

SPECIES	YEAR	March	Mar-Apr			April							Apr-May		May	
		28-30	31-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-29	30-2	3-5	6-8	9-11
CLLA	1979												4	4		5
	1980							9	4		5		5			
COUM	1979												1(2)	1(2)		3(2)
	1980							1	1(1")		3(3")		4(4")			
PRVI	1979												1	1		2
	1980							9	1		2		4			
BERE	1979								9				1	4		4
	1980							9	9		4		5			
AMAL	1979															
	1980							9	1		2		4			
ACGL	1979															
	1980							9	1		2		5			
CHVI	1979	2			2		2		2		2		2	2		3
	1980							9	2		2		3			

Blacktail Mt. Winter Range (Felix Canyon)

SPECIES	YEAR	March	Mar-Apr			April							Apr-May		May	
		28-30	31-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-29	30-2	3-5	6-8	9-11
AGSP	1979	9			2(1)		2(1)		2(1)				2(2)	2(2)		2(2)
	1980								2(2½)		3(5)		3(7)			
FEID	1979	9			1		1		2(1)				2(2)	2(3)		2(3)
	1980								2(2½)		3(4)		3(5)			
POSA	1979								2(1)				2(2½)	2(2½)		
	1980								3(2)		3(3)		3(5)			
STCO	1979								2(2)							
	1980								2(1½)		2(2)		3(4)			
PHHO	1979												4	5		5
	1980								2		5		5			
DEBI	1979												3	3-4		3-4
	1980										4		4			
GEVI	1979													2(2)		2
	1980										2		2			
COUM	1979													2(1)		2(1)
	1980										2(2)		4			
IRMI	1979													2(3)		2(4)
	1980								1		2(2)		2(5)			

Table 5. Continued.

Blacktail Mt. Winter Range (Felix Canyon) (Con't)

SPECIES	YEAR	March Mar-Apr 28-30	31-2	3-5	April 6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-29	Apr-May 30-2	3-5	May 6-8	9-11
AMAL	1979															
	1980										1		3			
ROWO	1979															
	1980										2		3			
BASA	1979	9			9		9		9				9	1		1
	1980								9		2(2)		4			

Brackett Creek Winter Range (Leffingwell's)

SPECIES	YEAR	March Mar-Apr 28-30	31-2	3-5	April 6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-29	Apr-May 30-2	3-5	May 6-8	9-11
AGSP	1979				2(2-3)		3(3)		3(3)				3(4)	3(5)		3(6)
	1980							2	2(2)		3(5)		3			
FEID	1979				2(1-2)		2(2)		2(2)				2(2)	2(3)		3(3)
	1980							2	2(1)		2(2)		3(4)			
KOMA	1979															
	1980															
CHVI	1979															
	1980															
BASA	1979															
	1980							9	1		2(1½)		4			
COUM	1979												1	2(1½)		2(2)
	1980							9	1		2(1½)		4			
LUAR	1979													1		2
	1980							9	1		2		2			
AMAL	1979															
	1980							9			1		2			
PRVI	1979															
	1980							9			2		3			
RAGL	1979				4								5	5		5
	1980							1	5		5		6			
VINU	1979												1	3		4
	1980							1	2		5		5			

[1] The first number is the phenological state: 1-Emerging or bud state, 2-early leaf, 3-late leaf, 4-early flower, 5-full flower, 6-early fruit, 7-mature fruit, 8-post seed drop, 9-dead or dormant

The second number, in parenthesis, is the average maximum height in inches.

Table 6. Phenology of lilac development and growth in Bozeman. Data provided by Donald K. Scharff, Professor, Biology Department, Montana State University, Ret.

Year	Early Bud Stage[1]	Lush Full Bloom[2]	Remarks
$\bar{X}$ 1955-1970	12 May	8 June	
1971	11 May	10 June	
1972	3 May	31 May	
1973	16 May	11 June	
1974	3 May	13 June	
1975	18 May	24 June	Latest recorded for both
1976	-	2 June	
1977	25 April	28 May	
1978	20 April	28 May	Earliest recorded buds
1979	13 May	2 June	
1980	27 April	22 May	Earliest recorded full bloom

[1] Early bud stage = first sight of flower buds, leaf buds will be open and new growth will be about 1" long.

[2] Peak of bloom

Environmental comparisons between the Armstrong and Brackett Creek Winter Ranges

This analysis provides preliminary comparisons of the existing vegetation (including habitat types and their distinct lower seral stages, distinguished herein as "cover" types), topographic features (slope and aspect) and geological substrates. Winter weather conditions for the two areas were compared above.

Vegetation

All cover types and the number of hectares and percentage of total area covered by each on each winter range are listed in Table 7. A cumulative total of 44 cover types was recognized. Only 6 of these were found on both winter ranges, 25 were found only on the Brackett Creek area, and 11 were found only on the Armstrong area. Thus a total of 31 cover types occurred on Brackett Creek, while 17 were found on Armstrong's. This suggested greater vegetational diversity on the Brackett Creek winter range; possibly resulting from more topo-edaphic and climatic variation, the vastly greater area included and/or greater disturbance by man.

Table 7. Cover type composition of the Brackett Creek and Armstrong mule deer winter ranges.

Cover Type	ARMSTRONG Hectares[1]	%	BRACKETT CR. Hectares[1]	%
ARTR/FEID/AGSP[2]	68.9	14.3	826.6	5.6
FEID/AGSP	30.8	6.4	443.8	3.0
ARTR/FEID/POPR	19.7	1.5	654.7	4.4
PSME/FEID	14.8	3.1	115.0	0.8
ARTR/FEID/PSME	12.3	2.6	135.7	0.9
PSME/CAGE	12.3	2.6	19.2	0.1
FEID/AGSP/STOC	34.5	7.1	0	
PUTR/AGSP	27.1	5.6	0	
PUTR/ARTR	36.9	7.6	0	
ACGL/PHLE	7.4	1.5	0	
JUSC/PUTR/ARTR	36.9	7.6	0	
JUSC/PUTR/FEID	7.4	1.5	0	
PHLE/SYAL	33.2	6.9	0	
CAGE/BRCA/PSME	54.1	11.2	0	
PSME/SYAL/CARU	61.6	12.8	0	
CARU/SYAL/PSME	14.8	3.1	0	
ABLA/CARU	12.3	2.6	0	
AGSP/CHVIL/ORHY	0		1291.6	8.8
RHTR/AGSP/PIFL/JUSC	0		847.8	5.7
POSA/ARFR/KOMA	0		790.3	5.4
AGSP/FEID	0		1927.1	13.1
ARTR/FEID/AGSP	0		1232.6	8.4
AGSP/ARTR/PUTR	0		210.85	1.4
AGSP/BASA/PSME	0		365.7	2.5
ARLU/FEID	0		19.2	0.1
ARTR/AGDA/AGSP	0		193.1	1.3
ARTR/POPR/PHPR	0		1021.8	6.9
POPR/FEID/LUAR	0		346.5	2.3
POPR/PHPR/GEVI	0		231.5	1.6
SYAL/POPR/PHPR	0		95.8	0.6
SALIX/ALNUS	0		558.8	3.8
Hayfields	0		1002.6	6.8
Grain fields	0		1194.3	8.1

Table 7. Continued.

Cover Type	ARMSTRONG Hectares	%	BRACKETT CR. Hectares	%
AGSM/FEID	0		38.3	0.3
Crested Wheatgrass	0		289.0	2.0
AGDA/KOMA/POSA	0		231.5	1.6
CAREX/SCIRPUS	0		19.2	0.1
PSME/ARTR	0		76.7	0.5
AGSP/FEID/BASA/PSME	0		19.2	0.1
PSME/SYAL/SYAL	0		174.0	1.2
POPR/PHPR/SYAL/PSME	0		193.1	1.3
PSME/POPR/PHPR	0		38.3	0.3
FEID/BASA/SYAL/PSME	0		19.2	0.1
POTR/SALIX	0		115.0	0.8
TOTAL AREA	482.47[1]		14,744.51[1]	

[1] The area represented by sample points occurring on steep slopes was adjusted for the secant error induced by observing such slopes from directly overhead assuming a mean steep slope declivity of 22 degrees.

[2] Symbols:
ARTR - Artemisia tridentata
AGSP - Agropyron spicatum
FEID - Festuca idahoensis
PSME - Pseudotsuga menziessii
POPR - Poa pratensis
CAGE - Carex geyeri
SYAL - Symphoricarpus alba
CARU - Calamagrostis rubescens
PHPR - Phleum pratense
BRCA - Bromus carinatus
ABLA - Abies lasiocarpa
CHVIL- Chrysopsis villosa
ORHY - Oryzopsis hymenoides
RHTR - Rhus trilobata
PIFL - Pinus flexilis
JUSC - Juniperus scopulorum
POSA - Poa sandbergii
ARFR - Artemisia frigida
KOMA - Koeleria macrantha
PUTR - Purshia tridentata
BASA - Balsamorhiza sagittata
ARLU - Artemisia ludoviciana
AGDA - Agropyron dasystachyum
LUAR - Lupinus argenteus
GEVI - Geranium viscosissimum
SALIX- Salix sp.
ALNUS- Alnus sp.
AGSM - Agropyron smithii
CAREX- Carex sp.
SCIRPUS - Scirpus sp.
POTR - Populus tremuloides or Populus trichocarpa
ACGL - Acer glabrum
PHLE - Philadelphus lewissii

The percentage distribution of cover types, grouped into broad growth-form classes, on each of the two winter ranges is shown in Figure 6. Somewhat similar proportions of both areas were occupied by grassland, shrub-grassland, and savannah-shrub grass types. However a considerable percentage of the Brackett Creek winter range was covered by agricultural cropland (including grain fields, hayfields, and crested wheatgrass seedings), none of which

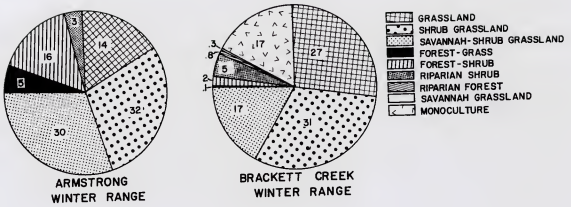

Figure 6. Area covered by nine vegetation growth form classes on two mule deer winter ranges in the Bridger Mountains.

occurred on the Armstrong area. Such croplands may be important for use by deer during early spring (Hamlin 1974, Nyberg 1980).

Greater coverage of forest types (both with shrub-grass and grass understories) was evident for the Armstrong winter range indicating that more thermal cover was available to deer on this area. The greater coverage of trees on the Armstrong winter range is also illustrated in Figure 7 which shows the percentages of each area occupied by broad tree-canopy-coverage classes discernable on aerial photographs. It might be assumed that tree coverage classes of less than medium density have limited value as thermal cover. Forest types with densities sufficient to provide good thermal cover comprised only a very small percentage of the vegetation on the Brackett Creek winter range, and much less than occurred on the Armstrong area.

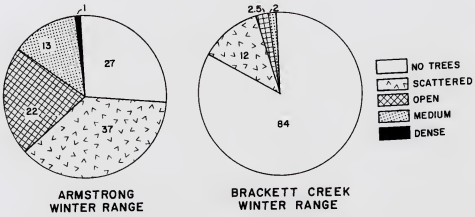

Figure 7. Occurrence of 4 different tree canopy coverage classes on two mule deer winter ranges in the Bridger Mountains.

The relative proportions of the two winter ranges covered by big sagebrush appeared to be very similar (Fig. 8).

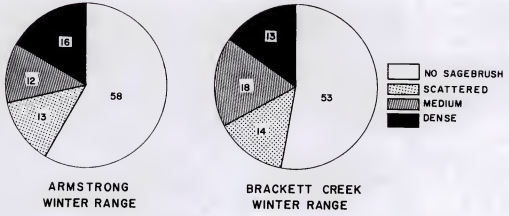

Figure 8. Area covered by 3 different sagebrush canopy coverage classes on two mule deer winter ranges in the Bridger Mountains.

Approximately 22 percent (108 hectares) of the Armstrong winter range was occupied by at least some antelope bitterbrush (*Purshia tridentata*) contrasted to <1.5% (210 hectares) on the Brackett Creek winter ranges.

Topography

Topography on winter ranged indirectly affects the welfare of the animals due to its effects on plant community composition and distribution. More directly, during the winter, topography creates microclimates, ameliorating or enhancing the climatic parameters governing the rate of deer energy loss. Four broad slope declivity categories (level, gentle, moderate, steep) were easily distinguishable on aerial photographs. Only the occurrence of steep slopes was analyzed. Steep slopes, as perceived on aerial photographs, were defined, on the basis of measurements at known points on the ground, as having declivities ranging from 17 to 40 degrees. The mean declivity for steep slopes on the Armstrong and Brackett Creek winter ranges was 22 degrees.

The steep slopes most influential in reducing energy loss during winter would be those facing toward the sun for a large percentage of the day; i.e., with aspects ranging from southeast to west. The percentages of total area of steep slopes by aspect for each of the winter ranges are shown in Figure 9. These data indicate that a much greater percentage of the Armstrong winter range is steep, as contrasted to the Brackett Creek winter range, and that more of the steep slopes on the Armstrong winter range face the sun, creating warmer microclimates during the day. The total areas occupied by steep slopes facing in SE-W directions, corrected for the secant error induced by vertical observation and measurement, are 155 hectares on the Armstrong winter range (32% of the winter range) and 1430 hectares on the Brackett Creek winter range (<10% of the winter range).

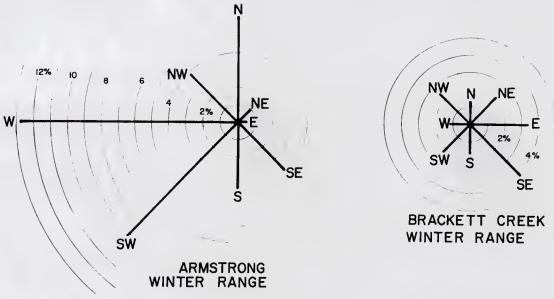

Figure 9. Percent of the total area of two winter ranges covered by steep slopes (17-40°) in each aspect.

Observations by Youmans (1979) indicate that the importance of steep north-facing slopes on the Armstrong winter range may be as great or greater than that of southerly facing slopes, because of the high availability of thermal cover on the north-facing slopes. Until one reaches the upper parts of the winter range, extensive forest stands are generally restricted to north-facing slopes. The availability of steep north-facing slopes on the Brackett Creek winter range is small, both on an absolute and comparative basis. However, even if such slopes were abundant in the Brackett Creek area, the likelihood of their furnishing significant thermal cover over much of the winter range is small. The lower Brackett Creek area is dry enough that establishment of extensive forest stands under the most favorable of microclimatic conditions is difficult. The greatest amount of thermal cover on the Brackett Creek winter range is not found on steep slopes; but rather, it exists as low areas out of the wind or level or near level declivities along creek bottoms. Observations by Nyberg (1980) indicated that deer did not seek out areas of high thermal cover or warmth during the winter of 1978-79, possibly due to the very small percentage of the winter range covered by such areas.

Geological Substrate

Geologically, the two winter ranges are very different. All of the Armstrong winter range is underlain by arkoses of the Precambian North Boulder group (McMannis 1955). Such rocks, when weathered, produce a generally well drained, course sandy soil relatively lacking in plant nutrients. Over 90 percent (13400 hectares) of the Brackett Creek winter range is underlain by sandstone of the Morrison formation (Iddings and Weed 1894) which produce sandy soils of a finer texture than those on the Armstrong winter range. Such soils can probably also be expected to have a higher base mineral content than those

on the Armstrong range. A small amount of the area (1.8% - 265 hectares) has been intruded by igneous (granite) dikes, whose main effect is to provide most of the steep SE and S-facing slopes on the lower part of the Brackett Creek winter range. The remainder (7.4% - 1100 hectares) of the winter range is covered by alluvial materials derived mainly from sediments of the Morrison formation, although some of the alluvium along Brackett Creek may have originated from various Paleozoic and Cretaceous rocks on the east side of the Bridger range. Also, this material is probably important more because of its topographic situation than because of any direct effects on deer.

Distribution, movements and habitat use

Winter

Distributional characteristics of mule deer in the Bridger Range during winter were described by Mackie et al. (1978). During 1979-80, overall distributions recorded during early and late winter helicopter surveys were similar to previous years. Weather conditions during early winter were generally mild and snow accumulations were below average. Deer were rather widely dispersed and extensively used timbered habitats on and adjacent to winter ranges. During the late winter survey, deer were more restricted and counting efficiency was higher, particularly on east slope winter ranges.

Recent data on the distribution of the Battle Ridge and Brackett Creek populations prompted changes in the location of winter range boundaries. The Battle Ridge winter range has been extended to include an area along U.S. Highway 89 just north of Wilsall (Fig. 1). Also, the southern boundary of the winter range previously located along the Brackett Creek Road, has been reestablished along the divide between Antelope and Looking Glass Creeks. That portion just north of the Brackett Creek Road including the Fox and Nixon Creek drainages is now included within the Brackett Creek winter range. Deer using this area seem more closely associated with the Brackett Creek population than with animals wintering on the northeast portion of Battle Ridge.

Summer

Spring, summer and fall distribution, movements, and habitat use of the Armstrong, Schafer and Brackett Creek populations have been closely monitored through relocations of radio-collared and neckbanded individuals. Limited data on seasonal movements have also been obtained for deer wintering near the mouth of Bridger Canyon; in the vicinity of Sypes Canyon; and on Battle Ridge.

Preliminary findings for seasonal movements of the Armstrong population have been discussed by Schwarzkoph (1973), Hamlin (1974), Pac (1976), Mackie et al. (1976), Mackie and Knowles (1977), and Mackie et al. (1978,1979). Data for the Schafer Creek population were discussed by Steerey (1979), while Nyberg (1980) presented findings for the Brackett Creek population.

Mackie et al. (1979) indicated that 15 (50%) of 30 deer radio tracked within the Armstrong study area during 1975-79 had summer home ranges in the Bill Smith and North Cottonwood drainages. Six (20%) of the 30 had summer home ranges in the Mill, Johnson, and Pass Creek drainages, while the east slope of the Bridger Range was utilized by 7 (23%) of 30 individuals with most summering in Frazier and Carrol Creek drainages. The remaining two deer (7%) had

summer home ranges in Tom Reese creek drainage. During summer, 63 percent of the radio-collared individuals were located within 3 air miles of the Armstrong winter range; the remainder were within 5 air miles.

Summer home range polygons averaged 0.65 mi^2 for 22 females and 2.32 mi^2 for 8 males (Table 8). Summer home ranges of Armstrong females are intermediate in size to those recorded for adult females on other study areas in the Bridger Range. Steerey (1979) recorded an average summer home range size of 0.32 mi^2 for nine females on Schafer Creek. Ten females radio-tracked on the Brackett Creek study area during 1978 had an average summer home range size of 1.13 mi^2 (Nyberg 1980). Average home range size of males on the Armstrong study area was substantially larger than the average of 0.30 mi^2 recorded for 3 males on Schafer Creek (Steerey 1979). Home range sizes of males were more variable than those recorded for females. Four of the 8 radio collared males on the Armstrong study area were tracked during the breeding season. The average summer home range size increased by 39 percent to 3.79 mi^2 when rut-related movements were included. One 7½ year old male (12-73) showed no extended movements during the rut; consequently its summer home range size remained the same.

Summer home range size for each year for individual deer radio-tracked from 1975-1979 are listed in Appendix Table 15. Among females, the largest individual summer home ranges were those of the oldest and youngest radio collared animals.

Deer 3-72 was 12+ years of age when radio collared in 1975. It had a localized and predictable summer movement pattern during 1975 and 1976. During 1977, she "wandered" extensively between the winter range and her former summer home range. Consequently, her summer home range increased in size from 0.33 mi^2 in 1976 to 1.99 mi^2 in 1977.

Movements of deer 40-78 was first monitored during her second summer. She gradually moved up the Tom Reese Creek drainage until early August and then crossed the Bridger Divide and utilized the Frazier drainage on the east slope. By mid-September, she returned to the vicinity of the Armstrong winter range about a month earlier than other adult females with summer ranges on the east slope. Therefore, her first summer as an independent adult was characterized by extensive and almost continual movement resulting in a home range size of 2.72 mi^2 (Appendix Table 15). The following summer, her movement pattern was more typical of other adult females. In mid-June, she moved directly to Frazier drainage and utilized a summer home range of 0.65 mi^2.

All 22 females radio tracked during 1975-79 on the Armstrong study area habitually used the same general winter and summer home ranges each year. Only two adult females have been known to leave the Armstrong herd range. A neck banded, 3½ year old female was seen on the Blacktail Mountain winter range and another marked doe of unknown age was observed on the North 16-Mile winter range during the late winter helicopter survey in March 1980.

Males generally seem to exhibit higher dispersal rates and some are less consistent in their use of winter and summer home ranges. Two neck banded males dispersed to other herd ranges during 1979-80. One moved from the Armstrong area to the Blacktail Mountain winter range while another moved from the mouth of Bridger Canyon to lower Canyon Creek on the Brackett Creek winter range. Other dispersal movements were documented in previous years.

Table 8. Average summer home range size for 30 mule deer radio-collared on the Armstrong winter range, 1975-1979.

Deer No.	Age when radio-collared	Sex	Years[1/]	Area[2/] km^2	Area[2/] mi^2
3-72	12½	♀	3	2.27	.88
1-73	12½	♀	2	1.11	.43
9-73	7½	♀	3	1.63	.63
11-73	6½+	♀	2	3.14	1.21
14-73	9½	♀	1	1.15	.44
19-74	7½	♀	3	1.97	.76
1-75	1½	♀	4	.99	.38
16-75	3½	♀	3	.89	.34
17-75	3½	♀	2	.79	.30
20-75	5½	♀	1	.82	.32
31-75	8½	♀	1	2.20	.85
7-76	5½+	♀	2	3.76	1.45
1-77	yg.ad.	♀	1	3.94	1.52
4-77	8½	♀	1	.97	.37
1-78	6½	♀	2	.69	.27
13-78	6½	♀	2	1.18	.45
20-78	5½	♀	2	1.08	.42
40-78	½	♀	2	4.37	1.69
41-78	8½	♀	2	1.05	.41
56-79	Ad.	♀	1	2.06	.80
69-79	7½	♀	1	.66	.26
70-79	7½	♀	1	.31	.12[3/]
Average				1.68	.65
2-72	4½	♂	1	8.94	3.45
12-73	7½	♂	1	2.09	.81
2-74	2½	♂	1	1.62	.62
6-75	7½	♂	2	.67	.26
8-75	7½	♂	1	17.57	6.78
1-76	5½	♂	2	5.89	2.28
7-78	1½	♂	1	9.61	3.71
51-79	2½	♂	1	1.72	.66
Average				6.01	2.32

Table 8. Continued.

Deer No.	Age when radio-collared	Sex	Years[1/]	Area[2/] km^2	Area[2/] mi^2
12-73+	7½	♂	1	2.09	.81
8-75+	7½	♂	1	23.02	8.89
1-76+	5½	♂	2	10.13	3.91
51-79+	2½	♂	1	3.99	1.54
Average				9.81	3.79

+ Home range size includes movements made during the breeding season.
1/ Number years radio tracked.
2/ Area based on connecting perimeter relocations to form a polygon.
3/ Died in late August.

Mackie et al. (1978, 1979) indicated that mule deer associated with the various winter ranges in the Bridger Mountains comprise population units which occupy fairly distinct and definable year-long or "herd" ranges. Figure 10 illustrates the general location and spatial relationships of each of the seven major herd ranges in the Bridger Mountains.

Overlap between individual herd ranges is most prevalent in Bridger Canyon and north of Flathead Pass east of the Bridger Divide. Those represent areas that are the greatest distance from winter ranges but are still within the range of mobility of mule deer using various winter ranges.

The Bridger mountains represent an "island type" mountain range that contains a long and norrow strip of relatively complex and diverse summer habitat with suitable deer winter ranges on all sides. The high deer densities that frequently occur in these situations may be partly related to the fact that this configuration potentially allows effective exploitation of all available summer habitats since so much of it falls within the range of mobility of the species. As illustrated in Figure 10, every part of the Bridger Range is used by deer. At no point in the Bridgers are the basic seasonal habitat requirements too far apart.

POPULATION CHARACTERISTICS

Trend and Dynamics of the Armstrong Deer Population

Trends in mule deer numbers and sex and age composition of the late winter-spring populations on the Armstrong winter range from 1973 through 1979 were discussed in detail by Mackie et al. (1978, 1979). Population estimates for mule deer using the Armstrong winter range during 1979-80 are presented in Tables 9 and 10. These were developed as Lincoln (Overton and Davis 1969) and Schnabel indices for observations of marked and unmarked animals during late winter.

Cumulative ground, aerial observations and trapping records provided knowledge of the numbers of marked deer on the area throughout the winter. At the end of April, approximately 101 deer wearing recognizable collars used the area between Tom Reese Creek and North Cottonwood Creek. Of these, 84 ranged between Bill Smith and North Cottonwood Creek. Even more marked animals could have been present since 8 of the 47 adults of unknown status were last seen during the spring of 1979.

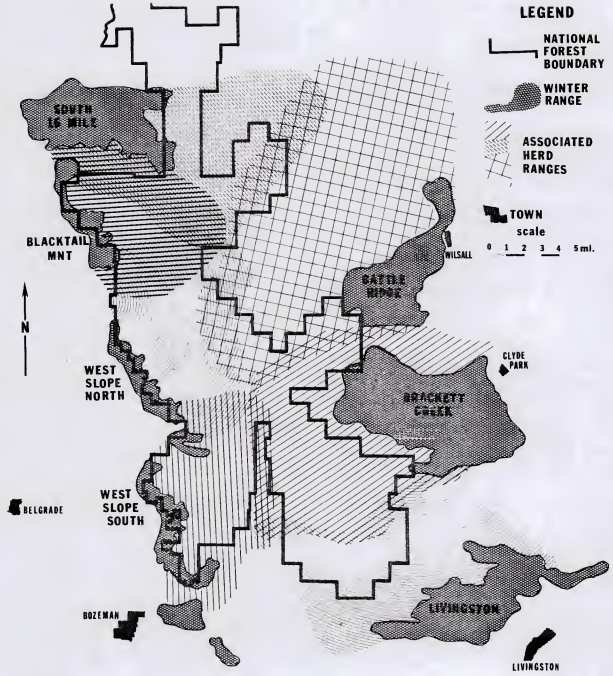

Figure 10. Location of the seven major mule deer winter and associated summer "herd" ranges in the Bridger Mountains.

Table 9. Late winter estimates of numbers of mule deer on the Armstrong winter range, April, 1980.

Estimated Numbers		Remarks
Total	S	
159	15.67	$\bar{X}$ Lincoln Index for 8 ground surveys (54-127 deer obs./survey) and 84-85 collars in population.
158		Schnabel Index for 8 ground surveys (54-127 deer obs./survey) and 84-85 collars in population.

Table 10. Estimated late winter-spring mule deer populations on the Armstrong winter range, 1973-80.

Year	Total No.	No. Adult Females	No. Males		No. Fawns
			Adult	Yearling	
1973	230	123	31	27	49
1974	220	130	27	23	40
1975	140	92	35	8	5
1976	170	118	37	3	12
1977	200	120	24	6	50
1978	160	116	6	6	32
1979	140	104	6	11	19
1980	160	95	14	7	44

The mean percentage of collared deer in April observations between Bill Smith and North Cottonwood Creeks was 53 percent, ranging from 43 to 57 percent in daily observations. Between 25 and 70 percent of all deer on the Armstrong range have been marked at various times during the previous six winters.

The best estimate of mule deer numbers on the Armstrong winter range was 160 during spring 1980. The mean Lincoln index for 8 ground surveys in April, was 159 mule deer (Table 9). The Schnabel index was similar at 158 deer. A point estimate of 159 deer is also obtained assuming a total marked population of 84 animals to represent 53 percent of all deer using the area between Bill Smith Creek and North Cottonwood Creek. That represents an increase of approximately 20 animals (14%) over the population estimate for spring 1979.

Estimates of mule deer numbers on the Armstrong range during early winter (Fig. 11) are more difficult to obtain than those for late winter when deer are more concentrated and observable. Using overwinter mortality rates of marked adults, fawn:female and male:female ratios observed during classification flights in January, an early winter population numbering about 183 deer was expected. This would have included about 96 adult females, 14 adult males, 8 yearling males and 65 fawns.

The estimated 160 deer on the Armstrong range in spring 1980 included approximately 95 adult females, 14 adult males, 7 yearling males, and 44 fawns (Table 10). When compared with estimates for early winter, overwinter mortality was light. Approximately 23 animals died, or 13 percent of the early winter population.

Known deaths included 14 fawns found dead during the winter or during a systematic search for carcasses in early May (Table 11). Overwinter fawn mortality was moderate with the total reaching about 32 percent of early winter numbers. Although some fawns died during the early to mid-winter period, most mortality occurred from mid-March through early April.

Confirmed adult mortality was limited to the trap-related death of a yearling male. The neckcollar of an adult female last seen alive on 4 May 1979 was found on the winter range during the spring carcass count. This individual was approximately 9½ years of age and was thought to have died during the 1979-80 winter.

Hunting mortality of males appeared to be lower in 1979 than the previous year (Table 12). Tag returns in 1978 indicated that 4 (36%) of 11 marked males were killed. During the 1979 hunting season only 2 (9%) of 22 marked males were known to have been killed. However, five (23%) of the 22 marked males which left the winter range in May 1979 and presumed to be alive during fall were not observed during the winter. Sixty-eight percent of the marked male sample was known to be alive at the close of the hunting season. Two other unmarked bucks were shot on the Armstrong area during fall 1979. Hunting was for males only, except for 500 either sex permits issued for national forest lands within HD 312 which includes the Bridger Range. Two (2.4%) of 83 marked females were harvested on the Armstrong area by permit holders (Table 12). One other adult doe was harvested in the vicinity of the Armstrong winter range.

A special questionnaire was sent to all 500 either sex permit holders for HD 312; 380 (76%) were returned. Harvest and hunting season projections were made from the returned sample for all 500 permit holders.

An estimated 335 (67%) of 500 permitees actually hunted deer in HD 312. Hunters averaged 3.8 days afield and 41 percent of those that hunted were successful. Of the estimated 136 deer harvested, 5 were whitetails. The 131 harvested mule deer included 66 adult females, 40 adult males and 25 fawns.

Hunter distribution and locations of 91 kill sites (46♀♀, 28♂♂, 17 fawns) are superimposed over the seven major mule deer herd ranges in Figure 12. Hunting pressure and harvest were not randomly distributed but "clumped" around several key access points. This situation could cause some herd ranges to absorb a disporportionate level of harvest if seasons are liberalized. For example, the comparatively small Blacktail Mountain population characterized by low-average recruitment and low adult turnover, would probably receive a higher harvest rate than the much larger and apparently more resilient Brackett Creek population which is characterized by higher rates of recruitment and adult turnover.

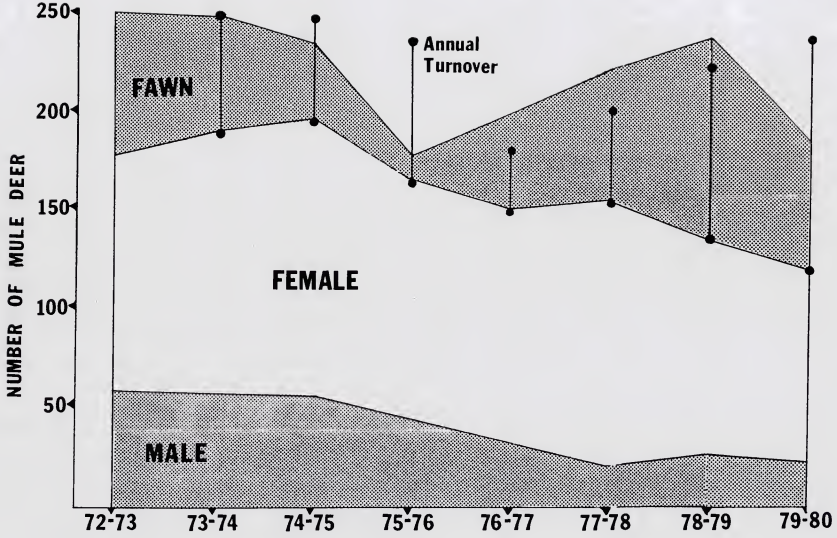

Figure 11. Early winter population trend of mule deer on the Armstrong winter range, Bridger Mountains, 1972-80.

Table 11. Number and age classes of winter-killed mule deer found on the Armstrong winter range, 1971-1980.

Year	Total	Fawns	Yearling	Prime	Old	Unknown
1971-72	19	9	-	-	10	-
1972-73	18	12	-	1	5	-
1973-74	12	10	-	-	2	-
1974-75	42	16	2	10	14	-
1975-76	2	2	-	-	-	-
1976-77	2	-	-	1	1	-
1977-78	25	11	-	-	7	7
1978-79	36	26	2	1	6	1
1979-80	14	14	-	-	-	-
Total	170	100(58.8%)	4(2.4%)	13(7.6%)	45(26.5%)	8(4.7%)

Table 12. Known hunting mortality of mule deer marked on the Armstrong winter range, 1972-79.

Year Marked	No. Marked	1972	1973	1974	1975	1976	1977	1978	1979	Total
1972	5	1(1½M)	1(2½M)	0	0	1(5½M)	0	0	0	3
1973	16	-	0	1(7½M)	0	0	0	0	0	1
1974	39	-	-	1(1½M)	0	0	2(4½M) (1O+M)	0	0	3
1975	36	-	-	-	2(4½M) (6½F)	1(3½M)	4(5½M) (7½M) (4½M) (7½M)	1(7½M)	1(9½F)	9
1976	9	-	-	-	-	0	1(Ad.M)	0	0	1
1977	16	-	-	-	-	-	2(2½M) (8½M)	0	0	2
1978	42	-	-	-	-	-	-	2(2½M)[1] (2½M)	2(3½M) (2½M)	4
1979	72	-	-	-	-	-	-	-	1(1½F)	1
TOTALS	235	1	1	2	2	2	9	3	4	24
No. Marked in Pop. [2]		5	20	56/58	67/69	64/78	66/87	72/109	105	
% Shot		20.0	5.0	3.5	2.9	2.8	11.8	3.3	3.8	

[1] An additional 2½ year-old male marked in 1978 was a probable cripple loss during the 1978 hunting season.

[2] 1974-1978 - Known no. marked/total possible marked deer that could have been present.

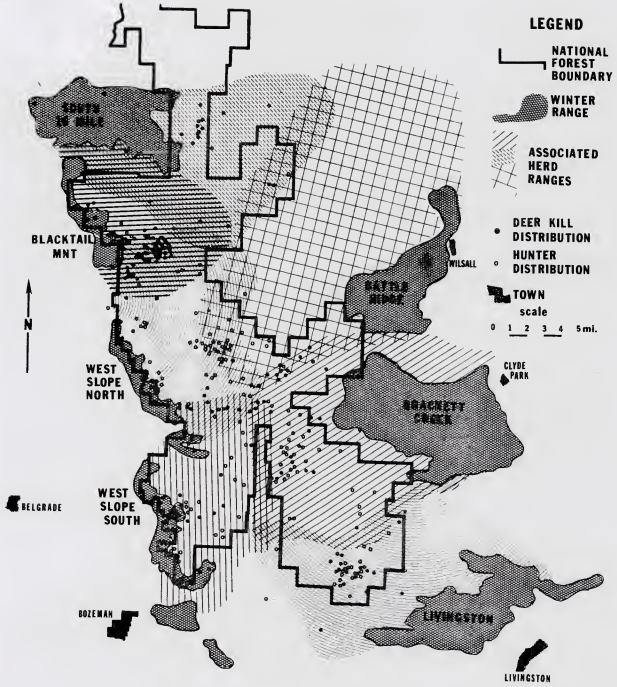

Figure 12. Hunter distribution and location of deer kills in relation to major mule deer "herd ranges" in the Bridger Mountains.

Sex and Age Structure in Relation to Population Phenomena

Figures 13 through 19 show changes in the sex and age structure of the Armstrong population from 1975 to 1980. Those data are reconstructions using population estimates and known or estimated ages of all deer handled in traps or that died or were killed on the area. Ages were determined for 93 (69%) of 134, 99 (63%) of 158, 92 (61%) of 150, 80 (63%) of 128, 76 (63%) of 121, and 95 (82%) of 116 adult deer in the Armstrong population during spring 1975, 1976, 1977, 1978, 1979, and 1980, respectively.

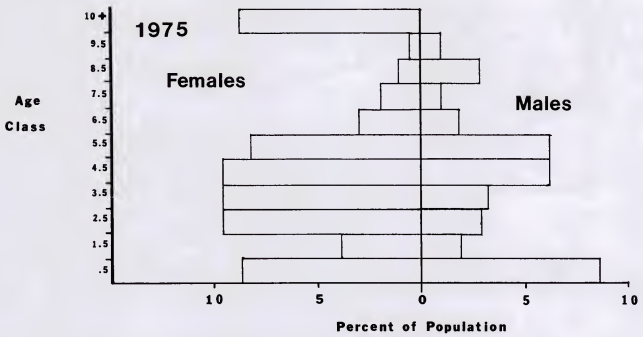

Figure 13. Sex and age structure of the Armstrong mule deer population, early winter 1975.

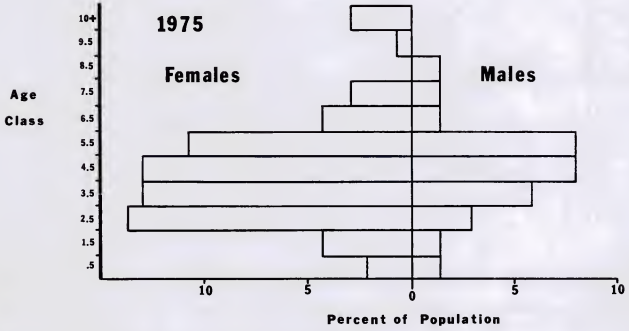

Figure 14. Sex and age structure of the Armstrong mule deer population, spring 1975.

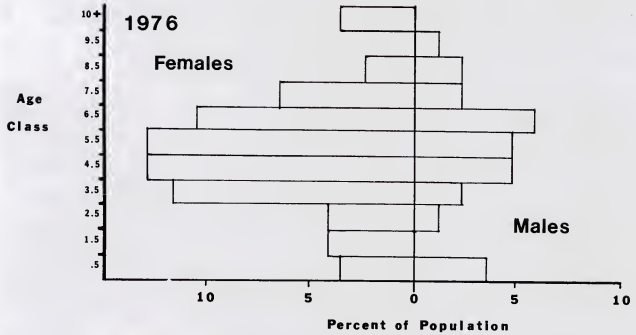

Figure 15. Sex and age structure of the Armstrong mule deer population, spring 1976.

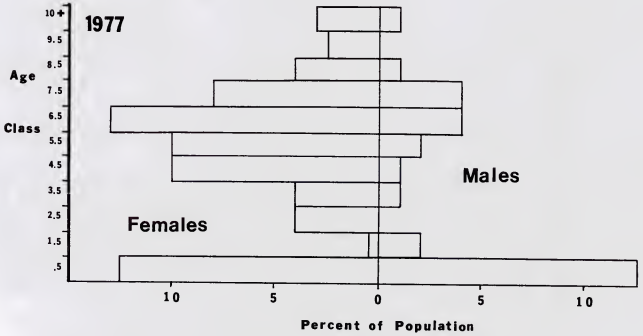

Figure 16. Sex and age structure of the Armstrong mule deer population, spring 1977.

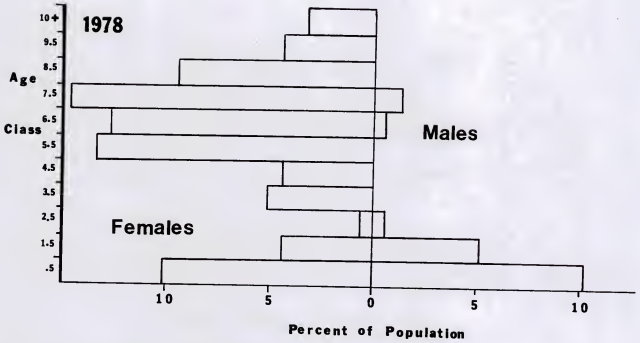

Figure 17. Sex and age structure of the Armstrong mule deer population, spring 1978.

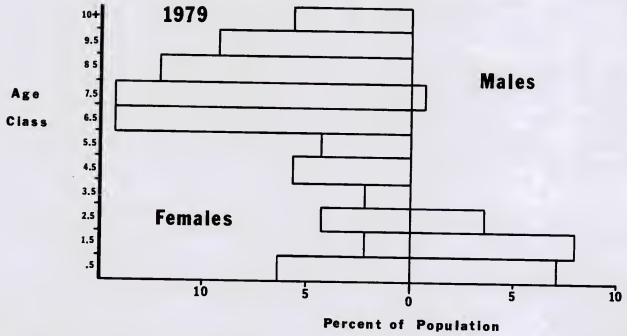

Figure 18. Sex and age structure of the Armstrong mule deer population, spring, 1979.

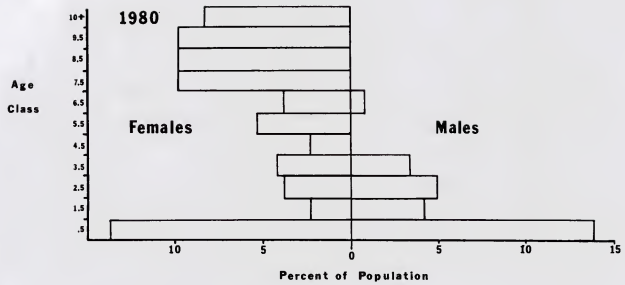

Figure 19. Sex and age structure of the Armstrong mule deer population, spring 1980.

The population in early winter 1975 was comprised of a preponderance of adults in younger (2.5-5.5 years old) age classes (Fig. 13). After the very long and severe winter of 1975, population structure in spring reflected extensive overwinter mortality and a 34 percent decrease in total deer numbers (Mackie et al. 1976). Young and old animals with high natural mortality rates were largely eliminated, resulting in a population primarily consisting of prime age classes (Fig. 14). During the following mild winter very little overwinter mortality occurred among fawns and adults. However, a delayed effect of the severe winter of 1974-75 was a very low rate of fawn recruitment in spring 1976, which can be attributed to extensive neonatal fawn loss during spring 1975 (Fig. 15). At that time the population was dominated by individuals with extremely low natural mortality rates and consequently the harvestable supply of adults, particularly females was very low during fall 1976.

In spring 1977, a majority of adult females occurred in the 4.5-7.5 age classes while most of the male segment entered age classes with higher natural turnover rates (Fig. 16). The recruitment rate was high as a result of an even milder winter than the previous one. Most of the adult males were removed from the population through heavy hunter harvest during fall 1977 and high overwinter mortality of the remaining bucks. Population sex-age structure in spring 1978 was largely comprised of females in the prime to late prime (5.5-8.5 years old) age classes and very young males in the 0.5 and 1.5 age classes (Fig. 17). Recruitment was low following the severe winter of 1978-79 while overall adult mortality was generally light (Fig. 18). After the mild winter of 1979-80, recruitment was the highest recorded since the study began and overwinter adult mortality was extremely low.

In spring 1980, the adult population age structure was dominated by old females (7.5-10+ age classes) and young males in the 1.5-3.5 age classes (Fig. 19). At that time, the female segment still showed the effects of the catastrophic mortality that occurred five years ago, during the winter of 1974-75.

The long lasting effect is particularly evident in a population characterized by low average recruitment and a long lived female segment. The manner and rate of removal of old aged females with high rates of natural mortality will strongly influence population trends in the next few years. Severe winters could cause catastrophic mortality with the rapid removal of a large percentage of the female population which in turn would adversely affect the size of subsequent fawn crops and overall population trend. If winters are mild, losses of old females may occur over several years, recruitment would be higher, resulting in a more stable population trend.

Age structural dynamics of the Brackett Creek population located on the east slope of the Bridger Mountains appear to be quite different from the Armstrong population, although both occur in the same mountain range. Data for the Brackett Creek population in spring 1979 indicated that very few females live beyond 8 years (Fig. 20). In contrast, large numbers of females older than 8 years occur in the Armstrong population. The Brackett Creek population apparently is characterized by higher rates of adult mortality and recruitment as compared to the Armstrong population.

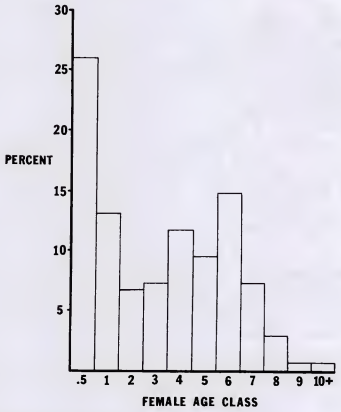

Figure 20. Age structure of female mule deer in the Brackett Creek population, spring 1979.

The sex and age structure of a deer population provides an ongoing record of the dynamics of that population in the particular environment it occupies. Any variation in environmental conditions that affects natality and/or mortality patterns or rates can also affect population structure. For this reason, there is no "typical" sex or age structure that will generally characterize all populations or apply to any one population entirely over time. Although the sex and age structure of a particular population is a dynamic characteristic, the changes that occur may follow a predictable pattern that is essentially determined by the longevity of adults and the recruitment rate of young. These naturally regulated changes in sex and age structure are of primary importance in determining the number of animals available for harvest in the population.

Fawn Production and Survival

Aerial classification of deer on the Armstrong Range during helicopter surveys in early January and mid-March 1980 and previous years are listed in Table 13. The observed ratios, 68 fawns:100 females and 55 fawns:100 adults in 1980 indicated comparatively high fawn survival to early winter when compared with other years. The late winter ratio of 38 fawns:100 adults was the second highest recorded since the study began in 1972. Even more favorable results were obtained when the data were converted to late spring fawn:female ratios and compared with previous years. Spring population estimates show 40 fawns: 100 females in spring 1973, 31:100 in 1974, 5:100 in 1975, 10:100 in 1976, 42:100 in 1977, 27:100 in 1978, 18:100 in 1979, and 46:100 in 1980. Therefore, fawn survival to spring was higher than all other years.

During early winter 1979-80, 6 (37%) of 16 males observed during aerial classifications were yearlings (Table 13). This compared with 6 (43%) of 14 males observed in early winter 1978-79 and 5 (46%) of 11 observed in early winter 1977-78. Recruitment of yearling males has been higher during the past three years than the 1975-1977 period, but lower than in 1973 and 1974. Seven yearling males were believed to have occurred on the Armstrong winter range in early winter and all survived to May.

General Population Characteristics of Bridger Mountain Mule Deer 1979-80

Totals of 1,889 and 5,081 mule deer were classified during the early and late winter helicopter surveys (Table 14). Only the west slope, Brackett Creek, and North 16-Mile winter ranges were flown in early winter. The entire Bridger Range including the North 16-Mile winter range were surveyed in late winter.

Total counts in early winter on west slope winter ranges were slightly higher in 1979-80 than in 1978-79 while totals for Brackett Creek and North 16-Mile were lower. Sampling efficiencies, estimated from marked animals, were approximately 45 and 28 percent for west and east slope ranges, respectively, compared to 40 and 48 percent respectively, in early winter 1978-79.

The total count for the entire Bridger Range in late winter 1979-80 was higher than that recorded at this time in 1978-79. Late winter sampling efficiencies for the west and east slopes were calculated as 49 and 51 percent. Using those data, a total population of 7,750 mule deer for the entire Bridger Range, excluding North 16-mile, was estimated for late winter 1979-80. This was substantially higher than the 1978-79 late winter estimate of 5,500, and suggests generally increasing populations, particularly on the east slope and South 16-Mile winter ranges.

Table 13. Aerial classifications of mule deer on the Armstrong winter range, January 1972 through March 1980.[1]

Reese Creek - N. Cottonwood	NUMBERS							RATIOS			PERCENTAGES		
	Total Count	Total Class.	Adults	Males	Females	Fawn	Uncl.	F:100 Females	F:100A	Males:100 Females	% Fawn	% Ylg. Males	% Spike Ylg. Male
1971-72 Jan. 3	173	173	119	39	80	54	-	68	45	49	31	56	26
Mar. 28	92	83	68	-	-	15	9	-	22	-	18	-	-
1972-73 Feb. 7	188	188	143	-	-	55	-	-	31	-	24	-	-
1973-74 Dec. 27	131	131	100	28	72	31	-	43	31	39	24	46	62
Apr. 1	188	188	154	-	-	34	-	-	22	-	18	-	-
1974-75 Jan. 5	140	140	116	37	79	24	-	30	21	47	17	19	17
Mar. 23	227	227	214	-	-	13	-	-	6	-	6	-	-
Apr. 20	99	99	96	-	-	3	-	-	3	-	3	-	-
1975-76 Jan. 2	121	121	113	29	84	8	-	10	7	35	7	7	100
Mar. 15	102	102	90	-	-	12	-	-	13	-	12	-	-
1976-77 Jan. 5-9	90	90	70	14	56	20	-	36	29	25	22	21	100
Mar. 10-11	116	116	87	-	-	29	-	-	33	-	25	-	-
1977-78 Dec. 19	133	133	94	11	83	39	-	47	42	13	29	46	40
Apr. 2	126	126	101	-	-	25	-	-	25	-	20	-	-
1978-79 Dec. 26	118	118	68	14	54	50	-	93	74	26	42	43	29
Mar. 12	98	98	68	-	-	30	-	-	44	-	31	-	-
1979-80 Jan. 9	132	132	85	16	69	47	-	68	55	23	36	37	50
Mar. 17	101	73	28	-	-	28	-	-	38	-	28	-	-

[1] Includes some animals ranging between Bill Smith and Reese Creeks not included in the Armstrong winter range population.

Table 14. Numbers and sex and age ratios of mule deer classified by aerial (helicopter) survey on various winter ranges in the Bridger Mountain complex during early and late winter, 1971-72 through 1979-80.

		1971-72		1972-73		1973-74		1974-75		1975-76		1976-77		1977-78		1978-79		1979-80	
		Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
NO. END WEST SLOPE	No. Classif.	204	352	523		367	356*	412	600	288	266	236	281	325	315	302	252	285	325
	♂:100 ♀♀	39.6	-			39.8	-	31.1	-	29.9	-	24.7	-	19.7	-	16.7	-	18.8	-
	FF:100 ♀♀	62.3	-	-		38.3	-	34.8	-	9.2	-	37.0	-	48.7	-	84.7	-	66.2	-
	FF:100 AD	44.6	29.9	32.7		27.4	19.0	26.5	9.4	7.1	6.1	29.6	34.4	40.7	30.3	72.5	39.9	55.7	46.4
SO. END WEST SLOPE	No. Classif.	470	332	271		174	162	459	448	335	307	335	365	336	121	277	473	325	504
	♂:100 ♀♀	39.1	-	-		39.6	-	22.8	-	28.6	-	27.2	-	25.0	-	11.2	-	20.4	-
	FF:100 ♀♀	45.4	-	-		32.6	-	51.1	-	25.8	-	46.1	-	53.7	-	61.2	-	61.4	-
	FF:100 AD	32.6	26.7	38.1		23.4	14.8	41.6	31.7	20.0	12.0	36.2	30.8	42.9	31.2	55.0	39.9	50.9	43.5
BLACKTAIL MOUNTAIN	No. Classif.	-	-	-		-	-	79	-	174	-	69	133	221	93	172	92	-	191
	♂:100 ♀♀	-	-	-		-	-	48.6	-	33.3	-	24.3	-	19.2	-	11.9	-	-	-
	FF:100 ♀♀	-	-	-		-	-	64.8	-	27.7	-	62.1	-	50.7	-	90.4	-	-	-
	FF:100 AD	-	-	-		-	-	43.6	-	20.8	-	50.0	37.1	42.5	40.9	80.8	27.8	-	59.1
SOUTH 16-MILE	No. Classif.	-	-	-		-	-	378	-	290	-	307	-	543	-	601	728	-	725
	♂:100 ♀♀	-	-	-		-	-	6.2	-	16.2	-	5.0	-	7.5	-	14.0	-	-	-
	FF:100 ♀♀	-	-	-		-	-	24.5	-	22.4	-	49.2	-	68.2	-	67.7	-	-	-
	FF:100 AD	-	-	-		-	-	23.1	-	19.3	-	46.8	-	63.4	-	59.4	46.8	-	71.3
NORTH 16-MILE	No. Classif.	-	-	-		-	-	665	483+	766	725	814	831	910	1050	1267	1041	700	1204
	♂:100 ♀♀	-	-	-		-	-	6.6	-	15.9	-	8.0	-	9.5	-	14.9	-	16.8	-
	FF:100 ♀♀	-	-	-		-	-	35.4	-	25.6	-	43.3	-	67.8	-	77.5	-	88.8	-
	FF:100 AD	-	-	-		-	-	33.2	32.7	22.1	10.0	40.0	25.9	61.9	39.3	67.6	47.6	76.0	65.8
BATTLE RIDGE	No. Classif.	-	-	-		-	-	-	-	148	-	81	-	388	-	629	515	-	608
	♂:100 ♀♀	-	-	-		-	-	-	-	5.3	-	24.5	-	22.8	-	24.6	-	-	-
	FF:100 ♀♀	-	-	-		-	-	-	-	25.6	-	54.1	-	78.2	-	96.1	-	-	-
	FF:100 AD	-	-	-		-	-	-	-	24.3	-	47.2	-	63.7	-	77.1	42.7	-	65.7
BRACKETT CREEK	No. Classif.	-	-	-		-	-	299	-	560	-	-	-	978	509	1120	1057	579	1017
	♂:100 ♀♀	-	-	-		-	-	11.3	-	5.0	-	-	-	12.2	-	13.1	-	7.5	-
	FF:100 ♀♀	-	-	-		-	-	49.4	-	32.5	-	-	-	74.1	-	77.2	-	81.7	-
	FF:100 AD	-	-	-		-	-	44.4	-	31.0	-	-	-	66.0	51.2	68.1	31.1	76.0	64.6
LIVINGSTON-BILLMAN CR.	No. Classif.	-	-	-		-	-	300	-	223	-	-	-	266	-	460	436	-	485
	♂:100 ♀♀	-	-	-		-	-	12.8	-	10.7	-	-	-	18.9	-	24.1	-	-	-
	FF:100 ♀♀	-	-	-		-	-	41.0	-	26.1	-	-	-	67.1	-	74.4	-	-	-
	FF:100 AD	-	-	-		-	-	36.3	-	23.6	-	-	-	56.4	-	57.6	28.2	-	63.9
OTHER MISCELLANEOUS AREAS	No. Classif.	-	-	-		-	-	-	-	-	-	-	-	28	-	26	-	-	22
	♂:100 ♀♀	-	-	-		-	-	-	-	-	-	-	-	7.1	-	11.1	-	-	-
	FF:100 ♀♀	-	-	-		-	-	-	-	-	-	-	-	92.9	-	100.0	-	-	-
	FF:100 AD	-	-	-		-	-	-	-	-	-	-	-	86.6	-	90.0	-	-	100.0
BRIDGER RANGE TOTALS	No. Classif.	674	648	794		541	518	2592	1531	2784	1298	1842	1610	4060	2088	4854	4594	1889	5081
	♂:100 ♀♀	39.3	-	-		39.7	-	14.8	-	16.5	-	13.5	-	14.6	-	16.0	-	19.1	-
	FF:100 ♀♀	50.3	-	-		36.4	-	38.7	-	25.1	-	45.0	-	66.4	-	77.7	-	78.1	-
	FF:100 AD	36.1	28.3	34.4		26.1	18.5	33.7	22.3	21.5	9.7	39.6	29.3	58.0	39.9	66.9	43.9	67.9	62.1

*Not including 100+ unclassified
+Northwest of 16-Mile Creek only

Losses during late December-mid March period were much less than those recorded for 1978-79. During 1979-80, only 13 percent of all deer present on the Armstrong winter range in early winter died, including less than 1 percent of the adults and about 32 percent of the fawns.

Mortality on Brackett Creek was estimated to be approximately 5 percent of early winter numbers. Using the mortality rates for the west and east slopes of the Bridgers, an early winter estimate of 8,350 deer was obtained which was somewhat larger than the 7,800 deer estimated during early winter 1978-79.

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Appendix Table 15. Summer home range size by year for 30 mule deer radio-collared on the Armstrong winter range, Bridger Mountains, 1975-1979.

Animal No.	Age when radio-collared	Sex	Years	Area[1] km²	Area[1] mi²
3-72	12½	♀	1975	.82	.32
			1976	.84	.33
			1977	5.15	1.99
1-73	12½	♀	1976	1.08	.42
			1977	1.15	.44
9-73	7½	♀	1975	1.24	.48
			1976	2.15	.83
			1977	1.51	.58
11-73	6½+	♀	1976	2.21	.85
			1977	4.07	1.57
14-73	9½	♀	1979	1.15	.44
19-74	7½	♀	1977	1.61	.62
			1978	1.78	.69
			1979	2.52	.97
1-75	1½	♀	1976	.57	.22
			1977	1.80	.69
			1978	1.26	.49
			1979	.33	.13
16-75	3½	♀	1975	1.18	.45
			1978	.73	.28
			1979	.77	.30
17-75	3½	♀	1975	.87	.33
			1976	.71	.27
20-75	5½	♀	1975	.82	.32
31-75	8½	♀	1979	2.20	.85
7-76	5½+	♀	1976	3.98	1.53
			1978	3.53	1.36
1-77	yg.ad.	♀	1977	3.94	1.52
4-77	8½	♀	1977	.97	.37
1-78	6½	♀	1978	.76	.29
			1979	.61	.24
13-78	6½	♀	1978	1.15	.44
			1979	1.20	.46
20-78	5½	♀	1978	1.53	.59
			1979	.62	.24
40-78	1½	♀	1978	7.06	2.72
			1979	1.67	.65
41-78	8½	♀	1978	1.20	.46
			1979	.90	.35
56-79	Ad.	♀	1979	2.06	.80
69-79	7½	♀	1979	.66	.26
70-79	7½	♀	1979	.31	.12[2]
2-72	4½	♂	1976	8.94	3.45
12-73	7½	♂	1977	+2.09	.81
				2.09	.81
2-74	2½	♂	1976	1.62	.62

Appendix Table 15. Continued.

Animal No.	Age when radio-collared	Sex	Years	Area[1/] km^2	Area[1/] mi^2
6-75	7½	♂	1976	.82	.32
			1977	.52	.20
8-75	7½	♂	1977	+23.02	8.89
				17.57	6.78
1-76	5½	♂	1976	+ 7.29	2.81
				3.66	1.41
			1977	+12.97	5.01
				8.13	3.14
7-78	1½	♂	1978	9.61	3.71
51-79	2½	♂	1979	3.99	1.54
				1.72	.66

+Home range size includes movements made during the breeding season. Other data for males are representative of movements without this influence.

1/Area based on connecting perimeter relocations to form a polygon.

2/Died in late August.

JOB TITLE: Population ecology and habitat relationships of mule deer in Bridger Mountains, Montana (Distribution, movements and habitat use of mule deer associated with the Brackett Creek winter range, Bridger Mountains, Montana).

OBJECTIVES:

To determine the movements, distribution and habitat use of mule deer associated with the Brackett Creek winter range and compare the results of this study with similar studies conducted on the Armstrong and Schafer Creek winter ranges on the west slope of the Bridger Mountains and elsewhere; to prepare cover type and habitat type maps of the vegetation of the study area; and to determine population characteristics of the Brackett Creek deer herd in comparison with those of other mule deer populations in the Bridger Mountains and elsewhere.

FINDINGS:

Field work was completed during the spring of 1979 and the Final Thesis Report was submitted in January 1980 as a separate supplement to the 1978-79 Deer Studies Report for investigation on the population ecology and habitat relationships of mule deer in the Brackett Creek winter range, Bridger Mountains, Montana. An abstract of the thesis by Harvey E. Nyberg is presented below.

ABSTRACT:

A study was conducted from March 1978 to April 1979 in the Bridger Mountains, Montana. Objectives were to determine the distribution, movements, habitat use, food habits and population characteristics of mule deer associated with the Brackett Creek winter range. A total of 114 mule deer were marked, 18 with radio collars. Mule deer generally occupied two seasonal ranges: winter-spring and summer-fall. Movements between these ranges were usually abrupt and direct and did not involve the use of holding areas. Mule deer were distributed throughout the winter range in early winter. From mid-January to mid-February most were concentrated on a primary use area comprising about 37 percent of the total winter range. In winter, the movements of all but one of the deer centered on a series of subseasonal ranges. Polygon home ranges, standard diameters and average activity radii of 8 radio-collared mule deer averaged 12.9 km^2, 3.3 km and 1.4 km, respectively, and differed significantly with those of mule deer on other Bridger Mountain winter ranges. During summer, mule deer were distributed throughout the study area. Average polygon home ranges, standard diameters and average activity radii of 9 radio-collared mule deer were 2.9 km^2, 1.5 km and 0.6 km, respectively and appeared to be larger than those reported on other Bridger Mountain ranges. During winter, sagebrush, grassland and agricultural cover types received 37, 43 and 14 percent of all recorded use. Mule deer selected the Douglas fir type during the early, severe portion of the winter. The sagebrush, agricultural and Douglas fir cover types were most important during summer, receiving 27, 23 and 18 percent, respectively, of recorded use by mule deer. Browse, forbs, and grasses received, respectively, 48, 33 and 19 percent of total utilization at winter mule deer feeding sites and accounted for 56, 9 and 35 percent by volume of the contents of 38 rumen samples. During summer, browse received 69 percent of recorded use of forbs and grasses 24 and 7 percent, respectively, at 5 mule deer feeding sites. Lincoln Index population estimates of 2352 and 1642

were calculated for early and late winter, respectively. The mid-summer population was estimated as at least 2866 animals. Densities of mule deer were calculated to be 12/km^2, 23/km^2 and 16/km^2 during summer, early winter and late winter, respectively. On the primary winter range, the density of mule deer approached 62/km^2. An initial fawn:doe ratio of 150 fawns:100 does was noted for 8 radio-collared does though fawn production for the entire herd was less. Overwinter mortality totaled about 10 percent of all adults and 58 percent of all fawns present in early winter or about 30 percent of the entire herd. The Brackett Creek population was dominated by young and middle-prime aged deer. Maximum ages of deer handled during the study were 10½ for females and 8½ for males. Examination of reproductive tracts indicated production below that observed in 1978 and below the long term average for mule deer in the Bridger Mountains.

JOB TITLE: Habitat relations of mule deer associated with the Brackett Creek winter range.

JOB OBJECTIVES:

1. To determine movements, distribution and habitat use of the mule deer associated with the Brackett Creek winter range and to compare results of this study with results of similar studies conducted on the west slope of the Bridger Mountains.

2. To quantify the vegetation of various habitat types on the Brackett Creek winter range and compare these data with results from studies on the west slope of the Bridgers to determine whether a vegetation factor is responsible for population density and home range size differences between the two areas.

3. To determine public and hunter access and land use practices on the Brackett Creek herd range in relation to habitat use by mule deer.

INTRODUCTION

This study continues investigations initiated by Nyberg during the summer of 1978. Results of studies during the summer of 1979 appear in the 1979 Montana Deer Studies report (Mackie et al. 1979). This report includes results obtained during fall and winter 1979-1980.

STUDY AREA

The Brackett Creek study area, located in the east central portion of the Bridger Mountain Range complex, has been described previously by Nyberg (1979). It consists of the northern half of Bangtail Ridge, Brackett, Canyon and Bangtail Creek drainages to the Shields River. The northern boundary, however, has tentatively been expanded to include the southwest portion of Battle Ridge, including the Horse Creek, Nixon Creek and Fox Creek drainages. Additional relocations of a radio-collared buck, marked during March, 1980, and other neckbanded deer within this area during the summer of 1980 should help to further delineate this boundary.

METHODS

During the fall hunting season, an attempt was made to determine hunter harvest of the Brackett Creek population. Public access roads were monitored and hunters were interviewed and informed of marked deer in the area. Deer jaws were collected for aging purposes from successful hunters. Returns from questionnaires sent out with the either sex deer permits as well as interviews with landowners provided additional information on harvest.

Winter field studies commenced in January, 1980. Prior to this time, periodic relocation flights using a fixed-wing aircraft were conducted to follow distribution and habitat use of radioed deer as they moved from summer to

winter ranges. See Table 1 for list of radioed deer. From January through March flights were made biweekly to assess winter range habitat use and distribution. Ground routes were also walked on the winter range to determine distribution. Classifications were made and used in developing adult/fawn ratios and feeding sites examined. Rumens collected from dead deer will also contribute to food habits analysis.

Table 1. List and current status of radio-collared deer on the Brackett Creek Range.

Radio Channel	Sex	Age (at trapping)	Date Collared	Status (Remarks) As of June 1, 1980
1978 Trapping				
2/3.10	F	2½	3/15/78	On Summer Range (Miles Creek)
2/6.35	F	5½	3/29/78	On Summer Range (White Creek)
2/10.2	F	6½	3/21/78	Radio Dead
2/11.35	F	Adult	3/21/78	On Summer Range (Ward Ranch)
4/7.5	F	4½	3/27/78	On Summer Range (Elkhorn Ridge)
4/8.3	F	4½	3/15/78	On Summer Range (Miles Creek)
4/9.10	F	3½	3/27/78	On Summer Range (Pekenpaugh Ranch) (Radio = Sporadic)
4/10.1	F	6½	3/27/78	On Summer Range (Stone Creek)
4/12.15	F	6½	4/ 9/78	On Summer Range (Miles Creek)
1979 Trapping				
2/9.35	F	4½	3/ 7/79	Radio Dead
3/11.25	M	1½	3/ 7/79	Hunter Kill 11/22/79, Bangtail Ridge
3/12.25	F	3½	3/ 8/79	Found dead-Brackett Creek (4/12/80) (Possible dog kill)
4/4.2	F	6½	3/ 7/79	On Summer Range (Miles Creek) Subsequently found dead
4/5.2	F	3½	3/ 8/79	On Summer Range (Olson Creek)
4/6.2	F	4½	3/ 8/79	On Summer Range (Bangtail Creek)

Early and late winter helicopter surveys were conducted in January and March, respectively, to assess distribution, to estimate total population, and classification and habitat use on winter range. The Lincoln estimate method was used to develop a total population estimate. A late winter fixed-wing airplane survey was also conducted using a piper supercub. Data obtained from this census method were compared to the helicopter surveys and efficiency of the fixed wing survey was determined.

In March deer were trapped at two sites on the winter range using a cannon net as described by Mackie et al. (1975). Table 2 shows sex and age classifications of deer trapped and marked.

Table 2. Sex and age classification of deer trapped and marked on the Brackett Creek Range.

Radio or Neckband	Sex	Age (at trapping)	Date Collared	Status
		Trapping 1980 (Cannon net)		
4/2.25	M	2½	3/13/80	On Summer Range (North Side Battle Ridge)
G/W ⚠	M	½	3/13/80	OK
4/11.1	F	6½	3/14/80	Coyote kill 5/8/80
4/3.1	F	Adult	3/19/80	Summer Range (Sheep Creek)
4/1.1	F	Adult	3/20/80	Summer Range (Fox Creek)
R/Y **Y**	F	2½	3/20/80	OK

To calculate winter loss, a dead deer survey was conducted May 8, 1980 using a method similar to that described in the Michigan Department of Conservation: Upper Peninsula Dead Deer Survey (1956). Areas of heavy deer use as well as light use were sampled, by randomly selecting four 40 acre plots in each of three winter range sections. These plots were walked over by a group of eight people. Dead deer found were aged and sexed, and cause of death was determined.

In May weekly flights to locate radioed deer were again implemented to obtain information on dates and routes of migration for these deer back to their summer ranges.

This summer field season will emphasize gathering more complete data on the vegetational aspect of the winter range. This includes measuring additional cover type areas for shrub densities using point-center quarter method (Cottam, 1956) and canopy coverage using Daubenmire frames (Daubenmire, 1959). Annual forage production of the important shrubs will be obtained using methods described by Buscis (1974). Aerial locations of radioed deer will continue biweekly during summer to obtain additional data on summer home range use and fawn production.

RESULTS

Habitat Analysis

Vegetational measurements taken during summer 1979 included point-center quarter method (Cottam, 1956) to determine shrub densities on the various cover types of

the Brackett Creek winter range. These densities have been calculated but since more types will be measured in summer 1980 analysis of the complete data will appear in the final job report. Cover type mapping of the winter range was completed this winter and this will also aid in habitat analysis.

Frequency and canopy coverage of plants in the various cover types measured were also calculated and will be analyzed with additional data collected in summer 1980 and presented in the final report.

Hunter Harvest

Questionnaires returned from either sex permit holders in hunting district 312, and hunter and landowner interviews revealed that at least 25 mule deer were harvested within this study area during the 1979 fall hunting season. This included three marked males (a yearling and a 2½ year old that were neckbanded and a radioed 2½ year old). Table 3 shows the age and sex of deer killed.

Table 3. 1979 Fall hunter harvest on Brackett Creek Study Area.

Age	½	1½	2½	3½	4½	5½	6½	Adult	Total
Male	0	5	4	0	0	0	0	8	17
Female	1	1	0	2	1	0	1	0	6
Unclassified	2	0	0	0	0	0	0	0	2
Total	3	6	4	2	1	0	1	8	25

Population Estimates

Helicopter surveys provided data used in calculating a total population estimate for the Brackett Creek deer herd. Calculations were made using the total number of marked deer observed during the entire winter. The early winter survey was conducted January 11, 1980 when a total of 579 deer were observed and classified (See Table 4). Using the Lincoln index, the total population estimate for early winter was 2,105. Fawns made up 43.1 percent of the population, while adult males represented only 4 percent.

Table 4. Early winter helicopter survey, January 11, 1980.

Female Adult	Male Adult	Fawns	Total
306	23	250	579

81.7 Fawns/100 Adult females

76 Fawns/100 Adults

7.5 Adult Males/100 Adult Females

During the late winter helicopter survey conducted March 20, 1980, 1,017 deer were observed and classified (Table 5) giving an estimate of 2,010 total deer. At this time fawns made up 39.2 percent of the population. These data indicate that little mortality occurred between these two surveys.

Table 5. Late winter helicopter survey, March 20, 1980.

Adults	Fawns	Total
618	399	1,017
	64.6 Fawns/100 Adults	

On April 4, 1980 a fixed wing piper supercub survey of the Brackett Creek winter range was conducted. A total of 758 deer were observed, yielding a population estimate of 1,966. A comparison of the total numbers of deer observed in helicopter and fixed wing counts indicates that the latter was approximately 75 percent as efficient as the helicopter and that the estimate of total population were very similar.

Winter Mortality

Using a modified version of the dead deer survey described in the Michigan Department of Conservation information circular (1956) twelve 40 acre plots were searched. A total of nine dead fawns were found (2 males, 2 females and 5 unclassified) yielding an estimated 12 dead deer per square mile. Six of the nine dead deer fawns were winter kills, one a probable coyote kill, one a possible hunter loss, and one was tangled on a barbed wire fence. Deer use on the winter range encompassed approximately 15 square miles, thus an estimated 180 deer could have died over the entire Brackett Creek winter range.

Also during winter field observations, dead deer found included five suspected coyote-killed fawns, two winter killed fawns, a road killed fawn and a suspected dog-killed fawn.

Three radioed does were also found dead during April and May 1980. On April 12 a 4½ year old doe was found dead in Brackett Creek on her winter range, possibly a victim of a dog attack since bone marrow examination revealed healthy condition. On May 8 a 6½ year old doe was found on her winter range, with death attributed to a predator. Another doe (8 year old) had moved back to the summer range she occupied last year on May 9. One week later she was located from the air three to four miles north in an area where the carcass was subsequently found. Predators were also suspected as the cause of death in this instance.

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Submitted by: Al Rosgaard

JOB TITLE Mule deer population ecology, habitat relationships, and relations to livestock grazing management and elk in the Missouri River Breaks, Montana.

ABSTRACT

Fawn survival and total population number continued the sharp upward trend begun in 1978-79. Fawn survival during the last two years has been the highest recorded during the 1960-80 period. An estimated 1020 mule deer and 925 mule deer were on the south study area during early winter and spring 1979-80, respectively. Fawn survival and total population trends on the north study area continued to follow the same pattern as that on the south study area. Sixteen adult female mule deer had an average home range of 1325 acres. Four adult males had an average home range of 6050 acres. Movements of mule deer during severe winters are compared with movements during normal or mild winters. Information on dispersal and home range establishment of yearlings is presented. Dispersal distances ranged from 5 to 55 airline miles. Information on mule deer food habits during the 1960-80 period is presented and discussed.

Job Title — Mule deer population ecology, habitat relationships, and relations to livestock grazing management and elk in the Missouri River Breaks, Montana.

Job Objective — To further determine the environmental requirements of mule deer and factors regulating mule deer populations in the "breaks" type of eastern Montana.

To further determine the direct and indirect effects of livestock grazing management under rest-rotational and continuous grazing systems upon deer populations and habitat relationships and upon deer-elk inter-relationship in the "breaks" type.

To develop new and improved guidelines for management of mule deer populations and their habitats in the "breaks" type of eastern Montana and for consideration of deer habitat requirements in elk, livestock, and range management programs in this type.

INTRODUCTION

In 1960, an intensive study of mule deer and their relationship to elk *(Cervus canadensis)* and domestic livestock was established on a representative 75,000 acre area in the Missouri River Breaks approximately 25 miles northeast of Roy, Montana. Habitat use and population studies were conducted from June 1960 through September 1963 and intermittently from October 1963 through May 1964 (Mackie 1970). From the summer of 1964 through spring 1975, less intensive studies were continued on the area primarily to obtain population data for mule deer (Mackie 1976). Mackie (1970) presented historical information on mule deer in the "Breaks", discussed development of the existing population from the late 1930's through the early 1950's, and described trends in numbers, sex and age composition and harvest from 1960 through winter-spring 1964. Subsequent reports (Mackie 1966, 1973 and 1976) extended these data through early winter 1975-76. In July 1975, intensive studies resumed under the statewide deer research program to further evaluate factors regulating mule deer populations in the breaks type habitat of eastern Montana.

A mule deer population decline on the study area, which started in winter 1971-72, continued to 1976-77 (Mackie 1976, Hamlin 1977). Population declines have occurred on this area in the past, but recovery has generally started within a year or two of the decline. Low fawn production and/or survival and ultimately low fawn recruitment was apparently the problem involved in the continuing population decline of the mule deer herd in recent years (Mackie 1976, Hamlin 1977). Low fawn ratios in some prior years were associated with severe environmental conditions such as drought in 1961-62 and severe winters in 1964-65 and 1971-72. However, severe environmental conditions apparently cannot be implicated in the relatively low fawn production and/or survival during the years 1973-76. From 1972 to 1976 normal precipitation during the growing season and mild, open winters have been the general rule (Mackie 1976).

A preliminary report by Knowles (1976) indicated that coyote predation may have been an important cause of mortality of mule deer, at least during winter 1975-76. A graduate research project investigating mortality of mule deer fawns from birth to September was initiated in June 1976. Dood (1978) indicated that coyote predation was implicated in at least some summer mortality of mule deer fawns on the south side Missouri River Breaks study area.

Present work on the project emphasizes determination of fawn production and survival, population dynamics of the herd and causes and timing of mule deer mortality.

ACKNOWLEDGEMENTS

The quantity and quality of data collected on this project has been greatly enhanced by the superior flying and observational skills of Supercub pilot Larry L. Schweitzer of Denton and helicopter pilot Murray Duffy of Bozeman. Duane Pyrah has provided assistance and advice in all phases of the project. Dick Mackie has provided assistance and advice in all phases of the project and has provided unpublished data from the study area for 1960-1975. Shawn Riley has provided invaluable assistance during three summers. Dr. Robert Moore, Montana State University, is gratefully acknowledged for making Sherman livetraps available during the summer. Many other Department or former Department employees have provided valuable field assistance. The study is being conducted in part on lands comprising the Charles M. Russell Wildlife Range, administered by the U. S. Fish and Wildlife Service and in part on lands administered by the Bureau of Land Management and the East Indian Buttes Grazing District. The cooperation and assistance of these agencies in some aspects of the study, including some financial support of aerial surveys, is gratefully acknowledged, as is the assistance of many individual personnel. Numerous private landowners and ranchers on the study area have also cooperated to assist the study effort through the years.

STUDY AREA

The south study area encompasses all of the timbered "breaks" portion of the area described by Mackie (1970) as extending approximately 20 miles on a 4 to 7 mile wide belt adjacent to the Missouri River in Fergus County, Montana (Fig. 1). It comprised approximately 100 square miles between U.S. Highway 191 on the west, the Skyline Trail on the east, the Missouri River on the north and the Musselshell Trail on the south. Physiography, climate, land use and vegetation of this area were described in detail by Mackie (1970). Some of the work described in this report was conducted on the adjacent Missouri River Bottomlands described by Allen (1968) and NE across the river on the Nichols Coulee Resource Conservation Area (north study area) described by Knowles (1975).

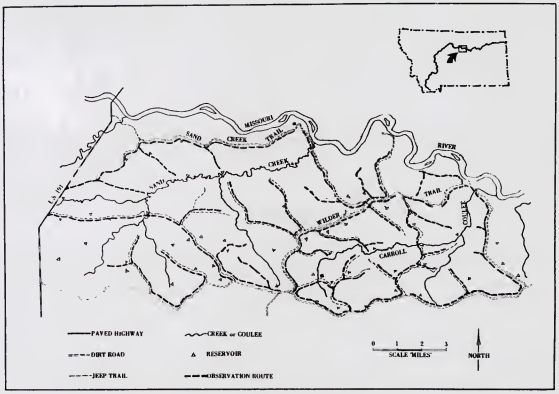

Figure 1. Map of the study area.

METHODS

Population data were obtained during fixed-wing surveys at various times of the year and helicopter surveys during December and March (Mackie, Hamlin and Pac 1980). Sex and age classifications and deer distribution and habitat use were obtained during all aerial surveys. Population estimates were made using data from helicopter surveys in most years. During the last 2 years, sufficient numbers of marked deer were present on the study area to permit usage of the Lincoln Index (Overton and Davis 1969) for all aerial surveys. Supplementary information was obtained throughout the year from the ground during the course of normal activities.

Data on initial fawn production and subsequent fawn survival were obtained by aerial and ground reconnaissance. Survival was also measured by following radio-collared fawns. The river and reservoir ice was flown periodically during winter to check for coyote-killed deer. The uplands were checked for coyote-killed deer during aerial flights to relocate collared deer and during other normal activities. Carcasses are listed as probable coyote kills based on evidence of tracks in the snow, trails of blood on snow or vegetation and other site evidence.

Deer have been captured during winter in order to attach radio transmitters or observational collars. Methods used have included the cannon net (Mackie et al. 1975), the Clover trap (Clover 1954), a helicopter drive net and darting from a helicopter. Newborn fawns were caught by the method described by Dood (1978).

Aerial relocations of radio-collared deer were obtained at 1-2 week intervals and relocations from the ground were made as time permitted.

Other techniques have been described in previous reports (Hamlin 1977, 1978 and 1979).

WEATHER

Data required to compute severity indices for winter 1979-80 were not available at the time of this report. In general, this winter was very open, with almost no snow cover and relatively mild temperatures. Precipitation has been much below normal for the past year, approaching drought conditions.

POPULATION TREND

South Study Area

Population data and classifications of mule deer on the study area from 1960-61 through 1979-80 are listed in Tables 1 and 2. Figure 2 extends Mackie's (1976) population trend estimates through 1979-80. Trend estimates for 1973-1977 have been adjusted somewhat from previous estimates on the basis of Lincoln Indices made during the past two years. These data indicated helicopter surveys sampled somewhat lower proportions of total deer on the area than employed in earlier estimates. Higher estimates for those years were also required for consistancy with estimates for 1978 and 1979. The population estimates made with the Lincoln Indices (Table 3) appear to be reasonable, since they are consistant with each other when the estimated fawn production and fawn and adult mortality between estimating periods are considered.

Fawn survival and population numbers have continued the sharp upward trend begun in 1978-79. Fawn survival during the last two years has been the highest recorded during the 1960-1980 period. Spring population levels are now nearly the same as at the highs in 1960 and 1970.

North Study Area

Population data and classifications of mule deer on the north study area from 1973-1980 are listed in Tables 4 and 5. Minimum counts indicate that this population is now at its highest level during the seven year period. Fawn survival trends have followed the same pattern as that on the south study area. Minimum density estimates continue to remain about one-half that of the south study area. A minimum population estimate for early winter would be 290 mule deer.

FAWN PRODUCTION AND SURVIVAL

Due to a change in reporting period, most of the available fawn production and survival data were discussed in previous reports. Table 6 lists data on initial fawn productivity annually from 1976 through 1979. Tables 7 and 8 show the extent and timing of fawn mortality for south and north study areas from 1975-76 through 1979-80. These data show that fawn survival was extremely high during 1979-80. Since initial fawn production has not been determined for the

Table 1. Sex and age composition of mule deer population on the Missouri Breaks Study Area, 1960-61 through 1979-80. Data were derived as aerial or ground classifications during December or early January of each year except 1969-70 and 1972-73, when classifications were completed during February and March, respectively.

Year	Type of Observation	Number Classified	Percentage			Ratios			% of Yrlg. Males	
			Males	Females	Fawns	Males: 100 FF	Fawns: 100 FF	Fawns: 100 AD	Obsv.	Harv.
1960-61	Ground[1]	668	9.3	48.6	42.1	19.1	86.4	72.6	56	46
1961-62	Ground	430	15.5	60.7	24.0	25.3	39.5	31.5	74	47
1962-63	Ground	190	19.5	52.1	28.4	37.5	54.5	39.7	63	34
1963-64	Aerial[2]	362	16.0	45.6	38.4	35.1	84.2	63.3	47	36
1964-65	Aerial	611	22.7	47.8	29.5	47.6	61.6	41.7	47	43
1965-66	Aerial	434	21.4	58.1	20.5	36.9	35.3	25.8	33	13
1966-67	Aerial	289	17.3	52.6	30.1	32.9	57.2	43.1	46	
1967-68	Aerial[3]	115	20.0	40.0	40.0	50.0	100.0	66.7	--	
1968-69	None	-	-	-	-	-	-	-	--	
1969-70	Aerial	110	-	-	39.1	-	-	64.2	--	
1970-71	Aerial	776	18.8	48.1	33.1	39.1	68.9	49.5	47	
1971-72	Aerial	679	19.0	53.8	27.2	26.1	50.6	37.4	46	
1972-73	Aerial	235	-	-	19.1	-	-	23.7	--	
1973-74	Aerial	370	24.1	49.5	26.5	48.6	53.6	36.0	43	
1974-75	Aerial	315	25.6	55.1	19.3	46.0	35.1	24.0	50	
1975-76	Aerial	323	15.5	57.6	26.9	26.9	46.8	36.9	28	
1976-77	Aerial	258	17.4	57.4	25.2	30.4	43.9	33.6	40	
1977-78	Aerial	322	10.9	58.7	30.4	18.5	51.9	43.8	48	
1978-79	Aerial	501	13.2	42.3	44.5	31.1	105.2	80.2	55	
1979-80	Aerial	675	11.3	41.0	47.7	27.4	116.2	91.2	54	

[1]Cumulative observations on area during December.
[2]All aerial observations by helicopter except 1969-70 (fixed-wing aircraft).
[3]Only west half of area surveyed in 1967-68.

Table 2. Classifications and observed recruitment of fawns on the south side Missouri Breaks study area, 1975-76 through 1979-80.

Date	Numbers	Adults	Young	Females	Males	Uncl.	Fawns/ 100 Adults	Fawns/ 100 FF
Sept.-Oct. 1975	105	69	36	50	19	-	52	72
December 1975	323	236	87	186	50	-	37	47
March 1976	193	173	19	--	--	-	11	--
October 1976	159	110	49	79	31	-	45	62
December 1976	258	193	65	148	45	-	34	44
March 1977	293	225	68	--	--	-	30	--
October 1977	112	70	41	51	20	-	59	80
December 1977	322	224	98	189	35	-	44	52
March 1978	255	195	51	--	--	9	26	--
September 1978	176	102	74	69	33	-	73	107
December 1978	501	278	223	212	66	-	80	105
March 1979	409	248	161	--	--	-	65	--
October 1979	278	157	120	100	57	1	76	120
January 1980	680	353	322	277	76	5	91	116
March 1980	683	375	308	--	--	-	82	--

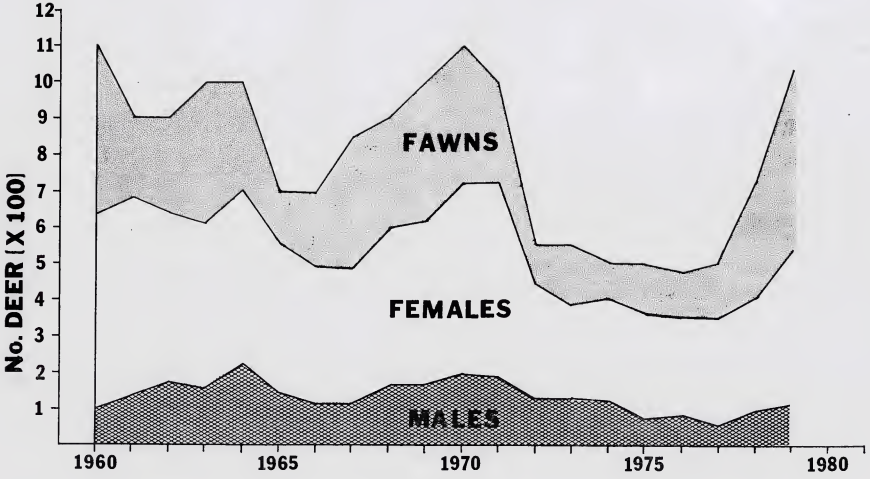

Figure 2. Population trend of mule deer on the Missouri River Breaks study area, 1960–1979.

Table 3. Population estimates of mule deer on the south Missouri River Breaks study area.

Estimated No. Deer on Study Area	Date	Remarks
732 406*	Dec. 1978	Lincoln Index - helicopter survey
556	March 1979	Lincoln Index - helicopter survey
639 387*	March 1979	December Lincoln Index minus est. 5% adult mortality and change in fawn/adult ratio
607*	June 1979	Lincoln Index - fixed wing survey
620*	July 1979	Lincoln Index - fixed wing survey
608*	Oct. 1979	Lincoln Index - fixed wing survey
1020 535*	Dec. 1979	Lincoln Index - helicopter survey
925 510*	March 1980	Lincoln Index - helicopter survey

* Adults only

north study area, but left at a constant 150 fawns:producing females, the relatively higher fawn survival on the north study area in 1979-80 may be an artifact of the technique rather than a real difference.

Coyote predation has been the greatest proximal cause of summer fawn mortality, even during those years of low mortality (Table 9). Coyote-killed deer found during winter are listed in Table 10. Other than hunting mortality of adult males, coyote predation has also been the proximal cause of most of the mortality of deer during the fall through spring period. In addition, two marked deer have been illegally shot and a few have either died or disappeared due to unknown causes.

MOVEMENTS

Sixteen adult females and four adult males have been relocated over periods of one year or longer. The 16 females had an average home range of 1325 acres (690-2450) or 2.1 mi^2 (1.1-3.8). The four males had an average home range of 6050 acres (5275-6850) or 9.45 mi^2 (8.2-10.7). Figures 3 and 4 show yearlong home ranges for an adult female and an adult male, respectively. These figures also illustrate movements typical of many deer during the severe winters of 1977-78 and 1978-79. The adult male was not marked during winter 1977-78, so its movements during that winter are unknown. During the two severe winters, many deer moved from their normal home ranges to portions of the

Table 4. December population summaries for mule deer on the north study area, NCRCA[1].

Year	Total	Adults	Fawns	Females	Males	Yearlings	Mature	Fawns/100 Females	Fawns/100 Adults
Pastures 3 and 4									
1973	184	134	50	100	34	18	16	50	37
1974	201	144	57	104	40	17	22	55	40
1975	208	172	36	119	53	19	34	30	21
1976	88[2]	63	25	42	11	1	6	60	40
1977	122	90	32	63	27	12	15	51	36
1978	160[2]	107	53	70	37	19	18	76	50
1979	263[2]	146	117	102	44	23	20	115	80

[1]Nichols Coulee Resource Conservation Area.
[2]Total count not obtained in comparable manner to other years; 1976-Jet Ranger, 1978 and 1979-Supercub.

Table 5. Classifications and observed recruitment of fawns on the north side Missouri River Breaks study area, 1975-76 through 1979-80.

Date	Total No.	Adults	Young	Females	Males	Fawns 100 Adults	Fawns/100 Females
Sept-Oct 1975	84	62	22	36	26	36	61
December 1975	208	172	36	119	53	21	30
March 1976	115	109	6	-	-	5.5	-
Sept-Oct 1976	65	48	17	29	19	35	59
December 1976	88	63	25	52	11	40	48
March 1977	118	92	26	-	-	28	-
October 1977	47	28	19	17	11	68	112
December 1977	122	90	32	63	27	36	51
March 1978	76	68	8	-	-	12	-
October 1978	86	60	26	34	26	43	76
January 1979	160	107	53	70	37	50	76
March 1979	192	137	55	-	-	40	-
October 1979	72	49	23	28	21	47	82
January 1980	263	146	117	102	44	80	115
March 1980	282	159	123	-	-	77	-

Table 6. Estimated mule deer fawn/female ratios in June and mid-July 1976-1979 on the south study area.

	Fawns/100 Producing Females		Percent Females Producing		Estimated Population Fawn/Doe ratio
June 1976	150:100(14)[1]	x	94[2]	=	141:100
July 1976	131:100(16)	x	71[3]	=	94:100
June 1977	152:100(27)	x	82[3]	=	125:100
July 1977	140:100(20)	x	76[3]	=	106:100
June 1978	165:100(26)	x	90[3]	=	148:100
July 1978	142:100(31)	x	83[3]	=	118:100
June 1979	176:100(37)	x	70[2]	=	123:100
July 1979	168:100(37)	x	70[2]	=	118:100

[1]Female sample size in parenthesis.
[2]Percent of female population older than yearling.
[3]Percent of females observed alone or with fawns.

area where steep south facing slopes dominated by greasewood (*Sarcobatus vermiculatus*) and steep north facing slopes dominated by Douglis fir (*Pseudotsuga menziesii*) occurred. Most deer that moved during severe winters remained within their normal yearlong home ranges during average to mild winters. During the mild winter of 1979-80, two deer made brief (1-2 day) movements back to the area used during severe winters and then returned to and remained within their normal home ranges.

Some information on dispersal and home range establishments of yearlings has been obtained during the past several years. Movement histories are known for seven males prior to and after their first year. All seven males dispersed from the area they had used with their mother for their first year of life. Dispersal distances ranged from 5 to 55 airline miles. The male for which the most relocations were made, wandered widely before establishing a new home range. Movement histories are known for six females prior to and after their first year. Five of these are known to have remained for 2-3 years within the home range they had used with their mother during their first year of life. One yearling female is believed to have dispersed from its prior home range. Contact was lost with this yearling female in June, during the time of dispersal. Her radio was working well to this time and did not show signal problems typical before radios quit. She has not been seen in her prior home range during the intervening year. Information from twin yearling females shows that they regrouped with their marked mother during the period September-May for two successive years. During the third winter, both siblings, as well as their mother, were accompanied by twins. Although all continued to use the same general home range, they were not observed together as often as during the previous two winters.

Table 7. Fawn production and survival on the south Missouri Breaks study area, 1975-76 through 1979-80.

	Fawns Per 100 Initially Producing Females	Approximate Mortality Rate	Percent Total Fawn Mortality	Total Fawn Mortality
1975-76				
Mid-June	150			
Mid-July	-	-	-	
October	83	-	-	
December	54	35	22	
March	16	70	28	
				89%
1976-77				
Mid-June	150			
Mid-July	101	33	45	
October	67	34	31	
December	47	30	19	
March	42	11	5	
				72%
1977-78				
Mid-June	152			
Mid-July	129	15	20	
October	98	24	27	
December	63	36	31	
March	38	40	22	
				75%
1978-79				
Mid-June	165			
Mid-July	131	21	43	
October	119	9	15	
December	117	2	2	
March	85	27	40	
				48%
1979-80				
Mid-June	176			
Mid-July	168	4	23	
October	171	0	0	
December	166	2	15	
March	150	10	62	
				15%

Table 8. Fawn production and survival on the north Missouri River Breaks study area, 1975-76 through 1979-80.

	Fawns Per 100 Initially Producing Females	Approximate Mortality Rate	Percent Total Fawn Mortality	Total Fawn Mortality
1975-76				
June	150			
		52	56	
October	72			
		51	26	
December	34			
		71	18	
March	10			
				93%
1976-77				
June	150			
		59	77	
October	61			
		18	10	
December	50			
		30	13	
March	35			
				77%
1977-78				
June	150			
		17	20	
October	132			
		52	49	
December	60			
		67	31	
March	20			
				87%
1978-79				
June	150			
		45	81	
October	83			
		0	0	
December	83			
		20	19	
March	66			
				56%
1979-80				
June	150			
		1	17	
October	-			
		-	-	
December	149			
		3	83	
March	144			
				4%

Table 9. Summer mortality and causes for marked mule deer fawns 1976-1979.

Year	No.[1] Marked Fawns	No. Died	% Mort.	No. Definite Or Probable Coyote Killed	No. Unknown	No. Accident	% Coyote Killed
1976[2]	11	4	36	4	-	-	100
1977[2]	19	6	32	4	1	1	67
1978[3]	15	2	13	1	1	-	50
1979[3]	21	3	14	2	1	-	67
Total	66	15	23	11	3	1	73

[1]No. marked fawns column includes unmarked twin of radioed fawn when this situation occurred.
[2]Data from Dood (1978) and personal communication.
[3]Data from S. Riley (pers. comm.).

Table 10. Probable coyote-killed deer found during winter (December-March).

	Uplands	Bottomlands	River Ice	Reservoir Ice	TOTAL
Mule Deer					
1975-76	9	2	1	33	45
1976-77	4	0	3	9	16
1977-78	5	0	2	1	8
1978-79	3	0	1	1	5
1979-80	0	0	2	5	7
White-tailed Deer					
1975-76	1	10	9	0	20
1976-77	0	1	3	0	4
1977-78	0	1	0	0	1
1978-79	0	1	1	0	2
1979-80	0	0	1	0	1

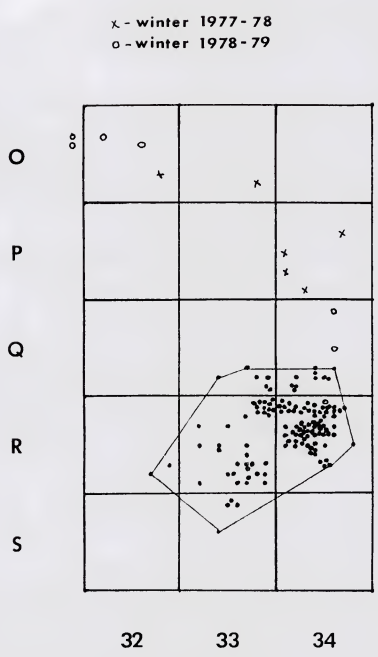

Figure 3. Home range of an adult female mule deer over a four year period.

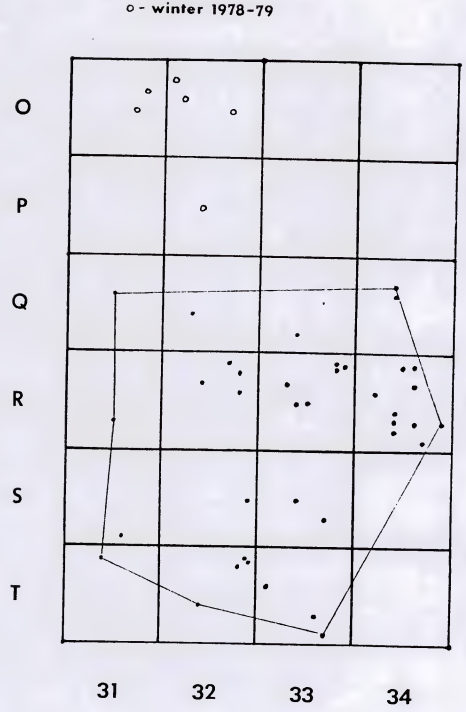

Figure 4. Home range of an adult male mule deer over a one and one-half year period.

FOOD HABITS

Fall and winter food habits of mule deer as determined by rumen analysis are presented in Tables 11 and 12. The 1961-63 period was generally one of higher deer density than the 1976-79 period. There have also been differences in the availability of yellow sweetclover (*Melilotus officinalis*) and green grasses among the years listed. These varying factors over the years should help to clarify mule deer food preferences in the Missouri River Breaks.

It appears that green, succulent forage is preferred at all times. During years when yellow sweetclover and grasses, primarily *Poa sandbergii*, are green during fall and winter, they appear to be preferred over all other species. Other highly preferred species during fall are snowberry (*Symphoricarpos* spp.), Rose (*Rosa* spp.) and rabbitbrush (*Chrysothamnus* spp.). Whenever the fruits of snowberry and rose are available, they appear to be preferred over other parts of the plant. During winter, rabbitbrush appears to be the preferred browse species as long as it is available. Big sagebrush (*Artemisia tridentata*) and Rocky Mountain juniper (*Juniperus scopulorum*) are the next most commonly used species. Snowberry and skunkbrush (*Rhus trilobata*) have been used much more during winter when deer numbers were low than when they were high.

Forage use during winter 1977-78 and 1978-79 was considered atypical because deep snow made much of the forage unavailable and forced deer to use areas not used in most winters.

The major difference between the 1961-63 period and recent times is that big sagebrush is used less now than previously. This may be due to both the greater intraspecific competiton in 1961-63 and to drought conditions during this period as compared to 1976-79.

Table 11. Fall food habits of mule deer on the south side Missouri River Breaks, 1961-1979.

	1961 (6)[1]	1962 (10)	1976 (2)	1977 (11)	1978 (8)	1979 (10)
Grass	43/100[2]	23/100	[3]T/ 50	37/100	T/ 13	T/ 20
Artemisia cana	-	5/ 30	-	-	-	-
Artemisia tridentata	15/100	T/ 10	-	-	-	-
Chrysothamnus spp.	25/ 83	7/ 70	67/100	20/ 82	T/ 13	24/ 90
Juniperus scopulorum	9/100	3/ 60	T/ 50	2/ 36	-	2/ 40
Pinus ponderosa	-	-	T/100	-	-	T/ 10
Prunus virginiana	-	T/ 10	-	-	-	-
Pseudotsuga menziesii	T/ 17	T/ 10	T/ 50	-	-	-
Rhus trilobata	T/ 33	T/ 20	T/ 50	-	T/ 25	1/ 50
Rosa spp.	T/ 17	1/ 40	8/100	1/ 82	4/ 88	15/ 90
Symphorocarpos spp.	T/ 33	3/ 50	19/100	37/100	41/100	27/ 90
Unid. browse	4/ 67	1/ 60	-	-	-	-
Total Browse	57/100	21/100	90/100	60/100	46/100	69/100
Artemisia longifolia	-	-	-	-	5/ 50	-
Chrysopsis villosa	-	-	-	T/ 27	-	-
Cirsium spp.	-	1/ 20	-	-	-	-
Comandra umbellatum	-	-	-	-	-	1/ 10
Compositae	T/ 17	-	-	-	-	-
Glycorrhiza lepidota	-	-	-	-	T/ 25	T/ 10
Leguminosae	-	9/ 10	-	-	-	-
Medicago spp.	-	5/ 20	-	1/ 9	-	T/ 10
Melilotus officinalis	-	16/ 30	-	T/ 9	50/100	27/ 70
Phlox hoodii	-	-	-	T/ 9	-	-
Tragopogon dubius	-	-	-	-	-	2/ 20
Yucca glauca	-	-	T/ 50	-	T/ 13	-
Unid. forbs	T/ 67	21/100	10/ 50	1/ 45	T/ 13	T/ 30
Total Forbs	1/ 67	54/100	10/100	3/ 64	55/100	30/ 90
Fungi	-	-	-	T/ 18	T/ 13	-
Lichen	-	-	-	-	-	T/ 10

[1]Number of rumens in parenthesis.
[2]Volume/frequency of occurrence in percent.
[3]T=trace=less than 0.5 percent.

Table 12. Winter food habits of mule deer on the south side Missouri River Breaks, 1961-1980.

	1961-62 (4)[1]	1962-63 (4)	1967-68 (6)	1976-77 (9)	1977-78 (5)	1978-79 (5)	1979-80 (6)
Grass	3/100[2]	19/100	1/ 17	[3]T/ 44	-	-	T/ 17
Atriplex nutalii	-	-	-	4/ 44	11/ 40	-	-
Artemisia cana	T/ 50	-	1/ 17	-	-	-	-
Artemisia tridenta	63/100	21/100	6/ 50	13/ 89	19/100	22/100	7/ 50
Chrysothamnus spp.	2/ 75	16/ 75	33/100	37/100	7/ 20	2/ 20	24/ 67
Juniperus scopulorum	16/100	9/ 75	9/100	18/100	17/100	29/100	9/100
Pinus ponderosa	-	-	T/ 17	-	33/100	16/ 60	1/ 17
Pseudotsuga menziesii	2/ 50	-	-	T/ 11	-	-	-
Rhus trilobata	T/ 25	T/ 25	1/ 17	8/ 78	12/ 80	5/ 40	27/ 83
Rosa spp.	T/ 50	-	T/ 17	T/ 33	-	3/ 20	T/ 50
Salix spp.	-	-	-	-	-	-	T/ 17
Sarcobatus vermiculatus	-	-	-	-	-	6/ 20	-
Symphorocarpos spp.	T/ 25	-	T/ 17	11/100	-	1/ 40	11/ 83
Unid. browse	T/ 50	7/ 25	13/ 83	T/ 38	-	1/ 40	1/ 33
Total Browse	95/100	53/100	63/100	91/100	99/100	85/100	80/100
Arenaria hookeri	-	-	4/ 17	-	-	-	-
Artemisia frigida	-	-	1/ 17	-	-	-	-
Artemisia longifolia	-	-	-	8/ 44	-	2/ 60	9/ 50
Aster spp.	-	5/ 25	5/ 83	-	-	-	-
Compositae	-	1/ 75	-	T/ 11	-	-	-
Haplopappus nutalli	-	-	11/ 33	-	-	-	-
Medicago sativa	-	T/ 25	-	-	-	-	-
Melilotus officinalis	-	-	-	T/ 11	-	T/ 20	11/ 67
Tragopogon dubius	-	5/ 25	4/ 50	-	-	-	T/ 17
Yucca glauca	-	-	T/ 33	-	-	1/ 40	-
Unid. forbs	2/ 50	15/ 75	11/ 67	T/ 22	1/ 20	12/ 60	-
Total Forbs	2/ 50	28/100	36/100	9/ 44	1/ 20	15/ 80	20/ 83

[1]Number of rumens in parenthesis.
[2]Percent volume/percent frequency of occurrence.
[3]T=trace=less than 0.5 percent.

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Submitted by: Kenneth L. Hamlin

JOB TITLE: Population ecology and habitat relationships of white-tailed deer on bottomlands of the Missouri River in northcentral Montana.

ABSTRACT:

Limited information was collected on a white-tailed deer population on the Missouri River bottomlands of northcentral Montana. The winter population size was an estimated 177 deer. The population has increased in size over the last several years, while fawn survival rates have increased for the last two years. Parallel increases in white-tail and the adjacent mule deer populations suggests common factors may be involved in controlling both species populations. The winter and summer distribution of white-tailed deer is discussed. Summer home ranges for two adult females were 106 and 147 acres.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer on bottomlands of the Missouri River in northcentral Montana, 1977-78.

JOB OBJECTIVES: To determine the environmental requirements of white-tailed deer and factors regulating whitetail population in major river bottom habitats of northcentral Montana.

To determine the effects of various potentially competing land use and management practices upon white-tailed deer in northcentral Montana.

To develop new and improved guidelines for management of northcentral Montana whitetail populations and their habitats.

INTRODUCTION

Few data are available on the population ecology and environmental requirements of white-tailed deer (*Odocoileus virginiana*) populations associated with floodplains of major rivers in Montana. The only existing study (Allen 1968) was conducted in 1964-65 on bottomlands of the Missouri River in northcentral Montana.

To meet the need for further information concerning white-tailed deer in river-bottom habitats, this study was established during 1975 on the same area on which Allen's (1968) study was conducted. Field studies were initiated during early winter 1975-76 and preliminary findings have been reported by Mackie and Knowles (1976) and Hamlin (1977, 1978 and 1979). Due to other work demands, field studies have not been intensive and were confined primarily to obtaining population data and information on deer distribution and movements.

STUDY AREA

The study area includes approximately 23 miles of floodplain and islands along the Missouri River in northcentral Montana (Fig. 1). General characteristics were described in previous reports (Mackie and Knowles 1976, Hamlin 1977, 1978, 1979). Physiography, climate, land usage and vegetation were described in detail by Allen (1968).

Figure 1. Map of study area.

METHODS

Periodic ground and aerial (Piper Supercub) surveys were made throughout the year to determine movements, distribution, mortality and survival of white-tailed deer.

The availability of previously radio-collared and neck-banded deer aided in determination of movements and allowed the use of the Lincoln Index (Overton and Davis 1969) to estimate population size.

RESULTS

Population Studies

Fawn/female and fawn/adult ratios were the highest recorded since 1961-62 (Table 1). Fawn/female ratios probably were somewhat higher than the 100/100 recorded, since some males were believed to have lost their antlers by the time of the 16 Jannary flight. In recent years, fawn survival in this white-tailed deer population has followed the same trend as recorded for mule deer in adjacent uplands. This may indicate the existence of a common factor affecting both populations.

The 141 deer observed during the early winter survey was the most observed since 1973-74. Lincoln Index estimates from four aerial surveys averaged 177 deer and ranged from 171 to 189 deer. These estimates may be minimum since more than the 16 marked deer verified may have been present. The estimate of 177 deer represents a density of about 22.5 white-tailed deer/ mi^2 of habitat.

Distribution and Movements

Table 2 shows that the damage or loss of habitat by flooding has changed the winter distribution of white-tailed deer on the study area between 1964 and the mid-1970's. There have been no major changes in the level of Fort Peck since 1975, and winter deer distribution has remained relatively constant since 1976-77. However, major winter concentrations on individual bottomland units have varied considerably among years (Table 2). The reason(s) for the changing use patterns of individual bottoms have not been detected.

Aerial observations of 453 white-tailed deer during summer-fall 1976-80 indicate that 30 percent were in the upper unit, 54 percent in the middle unit and 16 percent in the lower unit. These figures indicate that the lower unit receives greater use during summer and fall than during winter. Almost all of the summer-fall use of the lower unit is on its upper three bottoms (11-13). Movement to summer use bottoms was considerably delayed during the last two years when March flooding occurred. No flooding occurred during March 1980 and movement to summer home ranges had occurred by late March and early April.

Summer home ranges of 106 acres (24 relocations) and 147 acres (18 relocations) were calculated for two radio-collared adult female white-tailed deer. These summer home range sizes are similar to the summer home ranges of 160 acres or less of white-tailed deer in the coniferous forests of the Swan

Table 1. White-tailed deer numbers and sex and age composition from early winter surveys, 1960-1980.

Year	Numbers					Ratios			
	Total	Adult	Young	Female	Male	YG:100 AD	YG:100 Females	Male:100 Females	% Yearling Males
1960-61[1]	28	18	10	-	-	55.5	-	-	-
1961-62[1]	120	54	66	-	-	122.2	-	-	-
1962-63[1]	106	76	30	-	-	39.5	-	-	-
1964-65[2]	188	168	20	123	45	11.9	16.3	36.6	36.8
1965-66[2]	178	137	41	110	27	29.9	37.3	24.5	15.0
1966-67[2]	223	162	61	121	41	37.6	50.4	33.9	25.6
1971-72[2]	267	182	60	139	43	33.0	43.2	30.1	-
1973-74[2]	207	168	39	146	22	23.2	26.7	15.1	40.9
1975-76[2]	121	105	16	76	29	15.2	21.0	38.2	27.6
1976-77[2]	18	15	3	10	5	20.0	30.0	50.0	66.7
1977-78[2]	110	96	14	58	38	14.6	24.1	65.5	44.7
1978-79[2]	90	69	21	53	16	30.4	39.6	30.2	43.8
1979-80[3]	141	75	66	66	9	88.0	100.0	13.6	22.2

[1]Ground sample classifications.
[2]Helicopter surveys.
[3]Super Cub survey - 1-16-80, some males had probably lost their antlers, so both yg:100 female and male:100 female ratios would be somewhat higher than shown in the Table.

Table 2. White-tailed deer distribution during winter 1964-80, listed by percent of total per Bottom, Island and Unit.

Date	No. of Obs.	Bottom Number (See Fig. 1)																					
		SP	1	Two Calf Isl.	2	3	4	5	6	7	Harriet Isl.	8	9	10	Isl.	11	12	13	14	15	16	17	18	19	20
1964-65	717	-	3	Tr.	1	-	4	-	3	1	2	3	26	1	Tr.	2	-	Tr.	Tr.	7	26	11	2	4	3
1971-72	267	-	3	-	4	-	Tr.	9	9	8	3	-	17	6	5	-	-	15	-	20	Tr.	-	-	-	-
1973-74	207	-	4	-	4	-	4	4	4	46	2	-	-	-	-	10	-	19	-	3	-	-	-	-	-
1975-76	121	-	18	-	7	-	-	44	12	-	-	-	12	-	-	7	-	-	-	-	-	-	-	-	-
1976-77	131	-	16	-	24	-	-	2	18	4	11	-	25	1	-	-	-	-	-	-	-	-	-	-	-
1977-78	406	-	25	1	15	-	15	-	13	17	4	-	5	-	-	4	-	1	-	-	-	-	-	-	-
1978-79	494	-	28	-	10	-	14	4	22	13	-	1	5	2	-	Tr.	Tr.	Tr.	-	-	-	-	-	-	-
1979-80	340	6	11	-	19	-	2	38	6	6	8	-	1	-	-	2	1	-	-	-	-	-	-	-	-

		Upper Unit (SP-3)	Middle Unit (4-10)	Lower Unit (11-20)
1964-65	717	8	36	56
1971-72	267	7	51	35
1973-74	207	13	56	32
1975-76	121	25	68	7
1976-77	131	40	61	0
1977-78	406	41	54	5
1978-79	494	38	61	1
1979-89	340	36	61	3

Valley (Mundinger pers. comm.). Although a few marked deer have changed their area of summer use, most appear to use the same summer home range each year. As noted earlier, major wintering areas for the population vary among years. This is true of individual deer as well. Individual marked deer have often used different bottoms in different years and also move between several bottoms in the same winter. Movement between bottoms is rare during summer.

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Submitted by: Kenneth L. Hamlin

JOB TITLE: Population ecology and habitat relationships of mule deer and white-tailed deer in the prairie-agricultural habitats of eastern Montana.

ABSTRACT:

Population dynamics of mule deer in the prairie-agricultural type are discussed and compared with previous findings. Poor census conditions and a possible shift in winter distribution precluded definitive conclusions regarding population status. A population estimate was made assuming that large scale dispersal did not occur and that distributional changes were temporary. This estimate indicates a continuing upward trend in mule deer numbers. Post-hunting season male/100 female ratios continue to be low.

JOB TITLE: Population ecology and habitat relationships of mule deer and white-tailed deer in the prairie-agricultural habitats of eastern Montana.

JOB OBJECTIVE: To determine the environmental requirements of mule deer and white-tailed deer and factors regulating deer populations in the prairie-agricultural habitats in eastern Montana.

To determine the effects of various potentially competing land use and management practices upon deer in eastern Montana.

To develop new and improved guidelines for management of deer populations and their habitats in eastern Montana.

INTRODUCTION:

The Terry deer study was initiated in September 1975 as a part of the statewide deer research project. The general objective was to determine factors affecting and limiting mule deer (*Odocoileus hemionus)* and white-tailed deer (*Odocoileus virginiana)*numbers in the prairie-agricultural types of eastern Montana. Field studies were conducted from September 1975 through May 1976, after which, fieldwork was continued on a part-time basis. During 1979-80 studies were limited to aerial surveys to make population estimates and follow population dynamics. Coincident with aerial surveys, information was obtained on deer distribution and habitat use. Information collected previously was reported by Hamlin (1976, 1977, 1978 and 1979).

STUDY AREA

The study area is located in north Prairie and southwestern McCone counties on the west side of Highway 253, starting approximately 10 miles northwest of Terry and extending north to approximately 4 miles south of Brockway. The study area extends as far west as Little Sheep Mountain on the southern boundary and 5 miles west of Brockway on the northern boundary (Fig. 1). Approximately 230 square miles are included within the study area boundaries.

A general description of the topography, vegetation, land uses and history of the area was included in Hamlin (1976).

METHODS

Fixed-wing (Piper Supercub) aerial surveys were made to obtain population estimates, sex and age classifications, distribution and habitat use during three periods in 1979 and 1980: pre-hunting season (September), post-hunting season (January), and spring (March).

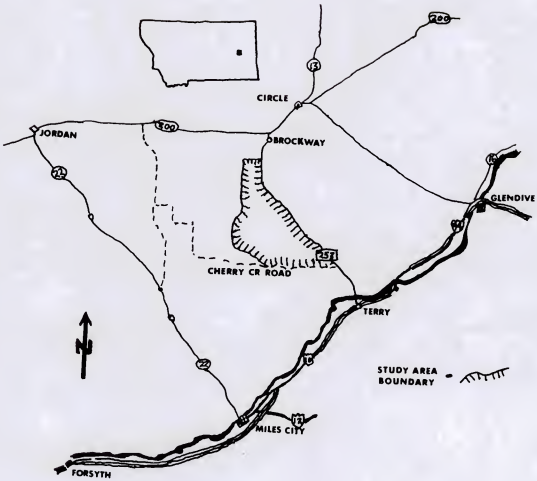

Figure 1. General location of the study area.

RESULTS

Mule deer fawn/female and fawn/adult ratios during winter and spring 1980 were high and at about the same level observed in 1979 (Table 1). In spite of a milder winter, overwinter fawn mortality was at about the same level in 1980 as in 1979. Fawn/adult ratios for white-tailed deer were higher than had been recorded during the past five years (Table 2). Little overwinter fawn mortality was indicated for white-tailed deer.

Due to the mild winter, census and observational conditions during both the early and late winter flights were poor. Only about half as many mule deer were observed as was expected, based on fawn production rates (Table 3). In addition to observational problems, fewer deer may have been observed because of winter distribution changes. At several places, the best winter habitat is near the boundary of the study area and these are the places where the biggest declines in observed deer numbers occurred. Past censuses have been made during average or severe winters. These censuses may have counted deer which are only on the study area during relatively severe winters. Thus, during the mild winter of 1979-80, deer previously observed and included in population estimates may have wintered off the study area. There were no marked deer in the population to verify or disprove this hypothesis; however, the equivalent situation has been documented in the Missouri River Breaks (Hamlin 1980).

The estimate of 600 mule deer for spring 1980 (Table 3) assumes that deer which use the study area during average or severe winters, were alive, but off the study area during winter-spring 1980. If extraordinary mortality or dispersal occurred rather than winter distributional changes, the estimate of 600 deer is too high. Marked deer and/or future flights will be necessary to determine the population's true numerical status.

The mule deer post-season male/female ratio of 10/100 (Table 1) is the lowest recorded in 5 years. The low male/female ratio may be the result of heavy hunting pressure (Hamlin 1979).

Table 1. Mule deer classifications on the Terry study area, 1975-1980.

	Total	Total Males	Yearling Males	Females	Adults	Fawns	Uncl.	Fawns/ 100 Adults	Fawns/ 100 Females	Males/ 100 Females
Sept. 1975	174	28	-	85	113	47	15	42	55	33
Dec. 1975	153	12	9	93	105	48	-	46	52	13
April 1976	134	-	-	-	86	43	5	50	-	-
Sept. 1976	125	24	14	55	79	39	7	49	71	44
Jan. 1977	252	40	20	124	164	72	16	44	58	32
Mar. 1977	167	-	-	-	110	57	-	52	-	-
Oct. 1977	272	51	20	119	170	101	1	59	85	43
Jan. 1978	413	57	32	203	260	152	1	58	75	28
Mar. 1978	319	-	-	-	214	96	9	45	-	-
Jan. 1979	517	35	-	203	238	223	57	94	110	17
Mar. 1979	289	-	-	-	164	125	-	76	-	-
Sept. 1979	185	19	10	86	99	80	-	81	93	22
Jan. 1980	361	17	8	169	186	175	-	94	104	10
Mar. 1980	225	-	-	-	129	96	-	74	-	-

Table 2. White-tailed deer classifications on the Terry study area, 1975-1980.

	Total	Males	Yearling Males	Females	Adults	Fawns	Uncl.	Fawns/ 100 Adults	Fawns/ 100 Females	Males/ 100 Females
Sept. 1975	119	21	-	42	63	50	6	78	119	50
Dec. 1975	229	29	16	102	130	79	19	61	78	28
April 1976	233	-	-	-	130	98	5	75	-	-
Sept. 1976	74	20	7	32	52	18	4	35	56	63
Jan. 1977	160	-	-	-	63	43	54	68	-	-
Mar. 1977	86	-	-	-	53	33	-	62	-	-
Oct. 1977	88	20	9	37	57	28	3	49	76	54
Jan. 1978	299	17	8	155	172	127	-	74	82	11
Mar. 1978	119	-	-	-	47	28	44	60	-	-
Jan. 1979	142	-	-	-	58	43	36	74	-	-
Mar. 1979	59	-	-	-	36	23	-	64	-	-
Sept. 1979	30	8	4	10	18	12	-	67	120	80
Jan. 1980	204	27	9	79	106	96	2	91	122	34
Mar. 1980	98	-	-	-	52	46	-	88	-	-

Table 3. Population estimates for mule deer on the Terry study area.

	Total	Adults	Fawns	Adult Females	Adult Males
Calculated June 1976	180	180	-	137	43
Calculated Winter 76-77	259	180	79	137	43
Observed Winter 76-77	252	175	77	132	43
Calculated June 1977	260	260	-	178	82
Calculated Winter 77-78	362	228	134	178	50
Observed Winter 77-78	413	261	152	204	57
Calculated June 1978	348	348	-	242	109
Calculated Winter 78-79	549	283	266	242	41
Observed Winter 78-79	517	267	250	228	39
Calculated June 1979	452	452	-	316	136
Calculated Winter 79-80	677	452	329	316	32
Observed Winter 79-80	361	186	175	169	17
Calculated* June 1980	600	600	-	435	155

*This estimate assumes that no unusual mortality of females and fawns occurred during the previous year and that the "missing" deer were not on the area due to the mild winter.

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MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

General Implications

Effective deer management requires understanding not only their habitat or environmental requirements, but also how deer populations operate and the processes by which they are regulated. This includes knowledge of basic deer-habitat interactions as well as the role of various intrinsic (animal/population) and extrinsic (habitat/environment) factors in the regulatory process.

Past attempts to explain deer population phenomena and regulatory mechanisms have centered around the concept of a more or less determinate "carrying capacity" (K), linked to the standing crop of forage on deer range. In practice, carrying capacity usually has been interpreted to directly relate deer numbers and dynamics to the supply and optimum utilization of winter forage -- primarily "key" browse plants on "key" winter range areas. Summer range or forage has been assumed to be generally adequate and of only minor importance in population regulation. The concept also holds deer populations to be inherently eruptive; i.e., they will tend to over-populate their range, over-utilize the forage supply, and ultimately reduce carrying capacity unless man intervenes. Because of this, management strategies have emphasized population control to "balance" deer numbers with winter forage and prevent over-use of browse plants. It is believed that populations held at or slightly below forage "carrying capacity" are the most productive and yield maximum sustained harvests; reducing deer numbers on "over-used" ranges will result directly in improved forage supplies, at least for individual animals, and improved fawn production and survival. Furthermore, trends in utilization, condition and production of key forage plants on key winter range areas would indicate whether deer populations were in balance with their forage supplies. They would also directly indicate management needs and opportunities.

In recent years, substantial emperical and experimental evidence has accumulated to indicate that deer-habitat interactions and population regulation involve more than a simple cause:effect relationship between deer population phenomena and winter browse supplies. It also has become increasingly evident that other assumptions underlying both the concept or traditional interpretation of carrying capacity and management strategies based on this concept may be invalid, at least in general application.

It now seems clear that winter forage, particularly browse, is only one of many environmental factors influencing the occurrence and dynamics of deer. In northern environments, characterized by long severe winters with deep snow, deer cannot and do not select and use winter range on the basis of forage alone. Data collected in the Bridger Mountains (Bucsis 1974, Mackie et al. 1976) and elsewhere (Wallmo et al. 1977) indicate that the quantity and quality of "key" browse on northern mountain-foothill winter ranges are insufficient to meet the minimum dietary requirements of deer. Information presented by Short et al. (1974) and Mautz et al. (1976) also supports this conclusion. It has been shown that deer

compensate for these nutritional deficiencies in winter by voluntarily reducing food intake (Wood et al. 1962, Silver et al. 1969, Thompson et al. 1973), reducing their basic metabolic rate (Silver et al. 1969 and others), utilizing previously accumulated fat reserves (Mautz 1978), and by selecting "habitats" and employing behavior that reduces the energy deficit (Loveless 1967). Comparisons of winter distribution and range use among our study areas indicate that deer select specific habitats and micro-environments that (1) enable deer to physically use an area in spite of prevailing climatic extremes and (2) favor energy conservation. Apparently, the harsher the environment, the more selective and specialized deer must be in order to exist and survive. At the same time, they may become less selective and more generalized in forage use (Nudds 1980). Youmans (1979) found that range use and behavior of mule deer on the Armstrong winter range in the Bridger Mountains reflected a strategy of energy conservation rather than foraging.

It also seems clear that deer are but one of many environmental factors influencing plant populations and forage supplies. Mackie (1973, 1976) found little correlation between utilization and condition trends of "key" browse plants on range survey transects (Cole 1958) on deer winter ranges in Montana. Browsing apparently was not the most important factor influencing browse plant populations on winter ranges in western Montana (Mackie 1973); though it may have been important in maintaining plant productivity, at least for some species. Similarly, Peek et al. (1978) reported that utilization of antelope bitterbrush by big game animals had not affected plant densities and may have been essential in maintaining both stands and productivity of this species on deer winter range in Idaho. Many other studies have indicated that most native browse species are well adapted to sustaining moderate to heavy utilization and may take advantage of such use that can stimulate annual growth and, in some species, vegetative reproduction as well. There is a wealth of ecological data to indicate that local site characteristics, plant succession, fire, livestock grazing, logging, activities of other wild animals, and prevailing climatic conditions basically determine trends in plant population characteristics and forage production. Forage production on rangeland can vary 2-3 fold between years due to differences in weather conditions alone (Blaisdell 1958, Mueggler 1972, Cable 1975); it can also vary generally over time due to long-term trends in weather conditions (Newbaurer et al. 1980).

We have not been able to demonstrate meaningful relationships between production-utilization-condition trends of major browse species and deer population phenomena, including winter mortality, on any of our study areas. Winter mortality patterns differed greatly among populations, and reflected deer-habitat interactions specific to each area and population. On all areas, the length and severity of winter and the susceptibility of the animals, as determined by numbers of deer in vulnerable age classes and their condition entering winter, would appear to be better predictors of winter mortality than measures of winter forage supplies. Browse utilization-production patterns also differed between areas as well as between years in the same area. These two parameters did not appear to be closely related; i.e., utilization did not directly influence annual production and vice versa. On all areas, utilization appeared to be

controlled by one set of environmental factors that influenced resource needs and habitat use patterns of deer; while annual forage production was determined by still another set of environmental factors that influenced plant growth.

None of this implies that winter forage is unimportant to deer nor that browsing and other activities of deer on winter range have no negative impact on forage supplies. At least some winter forage is always essential to maintain the rumen environment and basic digestive and metabolic processes which produce body heat. The nutrients derived from winter forage, while inadequate to maintain deer, also supplement and determine the rate and extent of use of body fat reserves. There are many reports in the literature which imply that deer have directly or indirectly altered local vegetative characteristics and forage availability. However, the role and importance of winter forage are woven into a complex that involves interactions between many environmental factors that influence deer populations over time. The role and importance of deer in influencing forage plant populations are similarly woven into another environmental complex that determines the occurrence, abundance and productivity of range plants. Because of this, we can no longer assume or base management strategies on the concept that "carrying capacity", and thus population regulation in deer, is controlled primarily by the winter forage supply. We also cannot assume that "carrying capacity" is a stable property of the environment, or that browsing and other activities of deer, if unmanaged, will directly reduce forage supplies and future "carrying capacities".

The results of our studies indicate that deer-habitat interactions and population dynamics must be evaluated and interpreted from a different perspective.

On our study areas, deer population parameters (numbers/density, age structure, fawn production/recruitment, and adult survival) have varied widely between individual populations (e.g., See Tables 1, 2, 3 and 4) even between those occupying closely adjacent areas. The normal range of variation in each of these parameters also differed. These differences have been consistent and appear to be characteristic of each population and the habitat it occupies. In the Bridger Mountains, characteristics and dynamics of individual populations vary in relation to the similarity of their year-long environments rather than the physical proximity of the populations. Apparently, the broader the difference in habitat, the greater the difference in population parameters and dynamics.

Within each population and its habitat, all population parameters appear to be functionally related; and these inter-relationships apparently are also characteristic or diagnostically unique. For example, high density populations were characterized by relatively high adult survival and longevity, low recruitment, and relatively greater stability than progressively lower density populations, which were characterized by generally lower adult survival, shorter longevity, higher recruitment, and greater variability.

We noted earlier that patterns of winter mortality differed greatly among study areas and populations, and that these differences reflected deer-habitat interactions that appeared to be specific to each area. On all

Table 1. Average reproductive success of mule deer in various habitat types as measured during winter.

	Fawns:100 Adults	Fawns:100 Females
Prairie-Prairie Badlands		
1. Eastern Garfield Co. 1961-1975 n=14	$\bar{X}$ = 62.2 S = 12.0	$\bar{X}$ = 78.3 S = 13.8
2. Terry study area 1965-1979 n=8	$\bar{X}$ = 72.0 S = 24.6	$\bar{X}$ = 89.8 S = 22.8
3. H. D. 611 1967-1977 n=8	$\bar{X}$ = 66.0 S = 17.8	$\bar{X}$ = 85.3 S = 18.9
4. Region 7 Total 1959-1980 n=20	$\bar{X}$ = 67.7 S = 13.7	
Breaks		
1. Missouri River Breaks study area 1961-1980 n=19	$\bar{X}$ = 47.6 S = 19.2	$\bar{X}$ = 64.2 S = 24.5
Mountain Foothills		
1. West slope of Bridger Mts. 1972-1980 n=9	$\bar{X}$ = 37.4 S = 13.7	$\bar{X}$ = 47.1 S = 15.7
2. NE Little Belt Mts. 1949-1976 n=28	$\bar{X}$ = 44.6 S = 8.4	
3. Sun River 1960-1975 n=15	$\bar{X}$ = 48.9	
4. South Snowy Mts. 1957-1976 n=16	$\bar{X}$ = 51.9 S = 13.6	
Northwestern Montana Mountains		
1. Region 1 Total 1973-1980 n=8	$\bar{X}$ = 39.4 S = 6.0	
2. Region 2 Total 1957-1977 n=18	$\bar{X}$ = 40.9 S = 8.3	

Table 2. Average spring recruitment of mule deer on three study areas.

	Fawns/100 Adults
Terry s.a. (Prairie hbt.) 1976-80 n = 5	$\bar{X}$ = 59.4 S = 14.5 range = 45-76
Missouri Breaks s.a. (Breaks-Badland hbt.) 1961-80 n = 9	$\bar{X}$ = 44.7 S = 23.2 range = 11-82
Armstrong s.a. (Mtn.-Foothill hbt.) 1972-80 n = 9	$\bar{X}$ = 21.7 S = 10.4 range = 4-38

Table 3. Average spring recruitment of white-tailed deer on two study areas.

	Fawns/100 Adults
Swan s.a. (W.Mt. Conif. Forest hbt.) 1958-80 n = 11	$\bar{X}$ = 44.3 S = 7.6 range = 33-59
Terry s.a. (Prairie-Agricultural hbt.) 1976-80 n = 5	$\bar{X}$ = 69.8 S = 11.7 range = 60 88

Table 4. Observed in utero fetal rates for mule deer in several habitat types and locations.

Location	No. Females	Fetuses/Female
Bridger Mountains	31	1.26
Regions 1 and 2	17	1.53
Snowy Mountains	11	1.55
Missouri River Breaks	14	1.86
Rosebud and Garfield Counties (Prairie Hbt.)	19	1.89

areas, the length and severity of winter and the susceptibility of the animals, as determined by the numbers of deer in vulnerable age classes and their condition entering the winter, seem to be the primary factors influencing the nature and extent of winter mortality. Deer populations along the west slope of the Bridger Mountains often experience catastrophic mortality during severe winters, even during periods of generally low deer density, when they contain many fawns and old animals. Winter mortality in the Missouri River Breaks has been high only during exceptionally severe winters preceeded by dry summers. Catastrophic mortality has not been observed in the Swan Valley; perhaps because weather patterns have been less variable and the population typically has included relatively few vulnerable animals. Such mortality has been recorded frequently and may be more characteristic of the adjacent Salmon Lake-Clearwater area.

Home range size and movement patterns of deer have also varied among study areas. The smallest seasonal home ranges occur among mule deer in the Bridger Mountains and white-tailed deer in the Swan Valley. Progressively larger home ranges have been observed in the Missouri River Breaks and prairie areas. The extent of seasonal movement and home range size on all areas appears to be related to and strongly influenced by the general nature and diversity of each habitat. Forage, cover, security and intraspecific isolation requirements can be satisfied in a relatively small area in complex, diverse and stable habitats. Thus, home range size may be governed largely by the behavioral responses of individual deer to inherent attributes of the environment. Population density does not appear to be a primary factor in home range size. Rather, as populations increase, overlap between home ranges increases to a limit determined by social tolerance. Thereafter, subordinate animals must disperse. Among females, social tolerance is lowest during summer, when dominant maternal does seek isolation. Social tolerance and overlap in home ranges is highest during winter.

Traditional interpretations of population regulation in terms of forage carrying capacity were not adequate to interpret inter-relationships between deer and their habitat on or among the various study areas. Likewise, they were not consistent with observed population dynamics. We have found no evidence that deer are "inherently eruptive", that potential fawn production and recruitment are high and similar for all ranges that are not over-utilized, or that reducing deer numbers on overused ranges will stimulate compensatory fawn production and survival. Rather, it appears that numbers, fawn production and survival, and other phenomena influencing the dynamics of deer are all expressions of the manner in which deer interact with and adapt to the total environmental complex in which each population occurs. Edwards and Fowle (1955) similarly concluded, from a general review of literature available, that the "... number of animals (in any area) is an expression of the interaction of the properties of the species concerned and the total environment in which it lives," and not the food supply alone.

Mackie (1978) proposed that population regulation in mule deer occurs as a result of interactions between inherent characteristics of available habitats and the inherent requirements and behavioral attributes of the

animals. Our findings provide additional evidence for that hypothesis and indicate that it also applies to white-tailed deer.

We conceive the regulatory process to include two functional components. The habitat includes all physical, climatic and biotic factors or features that determine the kinds, amounts, quality, distribution and diversity of resources available as well as the stability of resource outputs. The animal (deer) component includes the morphological, physiological and behavioral attributes and constraints of deer that determine their resource requirements as well as the "strategy" they can employ in exploiting habitat. This "strategy" includes all of the behavioral and biological adaptations deer may make to effectively use and persist in a given habitat or environment over time.

Within individual habitats and populations, basic deer-habitat interactions determine the particular strategies required and expressed. Ultimately, functional inter-relationships between "strategy" and environmental characteristics and factors determine other population phenomena and dynamics, including both "fill" and "turnover". "Fill" refers to the relative numbers or density of deer a given habitat can hold or sustain; "turnover" to the primary process through which regulation is expressed (Mackie 1978).

In this context, population behavior and dynamics of deer can be interpreted to both represent and indicate the strategy required to exploit a given habitat or environmental complex. At the same time, they can also be viewed as part of a broader "strategy" by which deer exploit diverse environments and/or maintain themselves in changing environments.

Because no two habitats or environments are exactly alike, each will entail deer-habitat interactions that effect different population strategies that will be reflected in different population phenomena. Thus, deer populations in each habitat will be characterized by different behavioral, biological and population characteristics as well as by different population dynamics. Similarly, environmental changes that broadly alter the nature of a given habitat or its resource outputs over time could be expected to effect changes in basic deer-habitat interactions and environmental relationships such that strategies and, thus, population characteristics and dynamics would also change.

When environments and interactions change slowly, deer may gradually "adapt" (i.e., evolve different "strategies") such that changes in population behavior and dynamics might be subtle and scarcely perceptible except as long-term differences. On the other hand, where sudden and drastic changes in environmental conditions cause extensive changes in the nature of a habitat, existing interactions and environmental relationships might be greatly disrupted. If deer were to survive or subsequently re-occupy that habitat, very different "strategies" as well as population phenomena and dynamics might be expected.

Our data have indicated that deer may employ a wide range of "strategies" in exploiting diverse habitats and in persisting in a given habitat over time. These strategies apparently are employed and expressed along a spectrum that at one extreme characterizes deer in variable, patchy,

temporary or unpredictable habitats; and, at the other extreme, characterizes those in complex, diverse and more permanent habitats that are relatively stable and predictable in resource availability and outputs. In the former, deer tend to be highly productive and short-lived. Populations are variable and may fluctuate widely between years or over periods of a few years. They tend to have high average fawn production-recruitment and adult mortality rates (high annual "turnover") and thus are comprised predominantly of young animals. In the latter, more stable habitats, deer tend to be less productive and much longer lived. Populations tend to be of relatively high density, at least within their primary yearlong range, and generally stable in that they increase or decrease only slowly. They also tend to be characterized by low and stable fawn production-recruitment and adult mortality rates (low annual "turnover"). Population age structures may vary, but usually include many old to very old animals. Deer in "intermediate" habitats also seem to be intermediate in "strategy" and population dynamics as compared with the extremes.

We have no evidence that deer, in exploiting a given habitat or environment that has changed over time, would or could employ the entire range of "strategies" indicated for all habitats. It appears that each broad habitat may dictate a normal range of strategies that comprises a portion of the total spectrum, corresponding to the inherent nature and characteristics of that habitat and its potential for change over time.

If these relationships and observations can be substantiated with additional data from studies conducted in other habitats, it should be possible to develop a "model" that relates deer population phenomena and dynamics to basic habitat/environmental characteristics across the spectrum of habitats available in the northern Rocky Mountains and Great Plains. This model could serve as a framework for correct interpretation of population data and habitat relationships of deer within all habitats in the spectrum. It might also provide basis for predicting population phenomena from habitat/environmental features and habitat characteristics and relationships from population data.

Specific Implications and Recommendations

From the foregoing, it seems obvious that some existing concepts or "principles" of deer management may be invalid; others may not be wholly applicable. Management strategies and practices based on these concepts should be carefully evaluated.

Our findings suggest that future deer management must be approached from a perspective in which deer population phenomena and dynamics are a function of their yearlong habitat or the total environmental complex in which a population occurs. In this perspective, each habitat will be somewhat unique; and deer numbers, reproductive and survival patterns and rates, and other population phenomena will differ consistently between populations and habitats. Management needs and opportunities or constraints will also differ. Judgements or generalizations about the relative "quality" of individual habitats, their potential to support deer or to sustain hunting, the importance of various "limiting factors", and management needs and benefits, could be extremely misleading without some specific knowledge of basic deer-habitat interactions and the "strategies" deer

follow in those habitats. Similarly, management practices applied broadly across large areas of diverse habitat could have different effects within individual habitats and populations.

Because of this, management must place greater emphasis on individual populations. All populations and their habitats should be defined and characterized as a basic part of the management process, and each must be considered separately in developing management strategy and plans.

This does not imply that intensive, research-type studies are necessary in all areas where deer occur, nor that each deer population and its habitat should comprise a separate management unit. Rather, we recommend: (1) general delineation and characterization of all population/habitat units that occur; (2) more intensive study and detailed characterization of important and representative units on a priority basis; and (3) continuing general assessment of population and environmental characteristics and changes over time.

In most areas, combinations of existing data, broad aerial surveys and field reconnaisance should be adequate to tentatively define and characterize individual population/habitat units. This would include basic information on population distribution, size and structure and major habitat-environmental features.

Aerial surveys and observations during winter can provide basic data on winter distribution and the locations of winter ranges or concentration areas. They can also provide general estimates of population size and sex/age structure, especially in more open habitats (Mackie et al. 1980). In some cases, existing data may suffice or provide supporting information. To identify population/habitat units, distributions should be mapped as accurately as possible on aerial photographs and/or topographic relief maps that encompass all adjacent or surrounding habitat used or potentially occupied during other seasons. In mountain-foothill habitats and other migratory situations, the location and juxtaposition of winter ranges and other seasonally occupied habitat will permit tentative delineation of population units and their yearlong range. In prairie, breaks, and other continuously occupied (nonmigratory) habitats, population units may have to be distinguished on the basis of local differences in population phenomena and/or environmental characteristics.

Once individual populations and their yearlong habitats have been identified and broadly characterized, it should be possible to generally assess major deer-habitat interactions, including the manner in which each habitat is used by deer, and the potential of each unit in terms of deer production and harvest. Complete units of similar characteristic and potential may then be grouped, particularly for harvest management. At the same time, it should also be possible to assess the management significance of each population/habitat unit and to establish priorities for further management activities--including more intensive studies of population and habitat characteristics and continuing general assessment of changes on individually important or representative areas.

Substantial refinement of management policies and development of specific guidelines for management of individual populations and habitats will require more detailed assessment of population and habitat characteristics

and how each population operates. For all important population/habitat units, including those considered representative of important deer "habitat types", we recommend that the following be obtained.

1. Distributional Characteristics

   (1) Total yearlong distributional range and the size of this area.

   (2) Winter distribution, including local areas used during most severe periods, and the size of these areas.

   (3) Summer-fall distributions, and spatial relationship between summer and winter ranges; the size of the areas included.

   (4) Distribution and movement patterns through the hunting season in relation to environmental conditions and hunter distribution and harvest.

2. Deer Population Characteristics

   (1) Population size and density, particularly during winter-early spring. General estimates of density distributions during other seasons may be developed in relation to distribution and movements.

   (2) Fawn production-recruitment rates, including average and "normal range".

   (3) Population sex and age structure, preferably by year class.

   (4) Numbers, sex and age composition and distribution of deer killed by hunters.

   (5) Occurrence, extent, and cause of any catastrophic mortality (i.e., unusually heavy loss due to weather, disease, predation, hunting, or other factors).

3. Habitat/Environmental Characteristics

   (1) General categorization of habitat/environment on the basis of topographic, physiographic, vegetational, climatic and land use; for the total area and specifically for winter and summer range.

   (2) General description of cover-habitat types, their location and size or extent, on winter and summer range.

   (3) General description of climatic characteristics, including seasonal temperature, precipitation (especially growing season) and winter severity.

   (4) General description of land use characteristics, including the location and extent of such use on both summer and winter range and the amount and location of public access.

At the present time, we suggest that 1-3 years of intensive survey and investigation should be adequate to define these characteristics for individual populations and habitats. This should also be sufficient to

develop a working knowledge of basic deer-habitat interactions and population dynamics from which management opportunities and constraints can be reasonably predicted.

Our findings have also indicated that carefully distributed samples of 12-20 radio-collared deer, relocated monthly or bi-monthly, will adequately define seasonal distributions and movements for individual populations in most habitats.

At the same time, a well distributed sample of approximately 20 collared deer may be adequate to estimate population size and/or develop visibility indicies for deer in conjunction with complete-coverage aerial surveys on winter range in many habitats, especially those of mule deer (Mackie et al. 1980). Using only radio-collared deer as marked samples, the number of marked deer on the census area could be determined by relocation immediately after counts have been completed. Once visibility bias for a individual habitat and type of aircraft used has been established, further use of marked animals may not be necessary to develop annual population estimates from aerial surveys (Mackie et al. 1980).

Aerial surveys will not be applicable in heavily timbered habitats as in northwestern Montana. Here, other techniques such as spotlight counts and line or pellet count transects may be more appropriate, or new techniques may have to be developed. General population estimates may also be developed from harvest data when substantial numbers of deer have been marked in a given habitat.

Fawn recruitment rates may be determined in conjunction with aerial surveys on winter range and/or through ground counts and classifications. If possible, these data should be obtained during both late fall-early winter and late winter-early spring periods. The former would also provide estimates of adult sex ratios; while the latter will provide the best estimates of actual fawn recruitment.

Age-structure of individual populations can be obtained through collections of lower jaws or incisiform teeth from hunter-killed deer, road kills or other natural mortality, and by specifically "aging" deer handled in trapping operations. Age should be determined or estimated to the nearest year. Collection of these data, as well as determinations of the numbers, distribution and sex-age composition of deer killed by hunters may be improved by more extensive use of checking stations and/or by issuing special either-sex permits and specially directed questionnaires and requests for lower jaws.

When basic population estimates and other data have been obtained for two or more successive seasons or years, estimates can be verified or refined and the dynamics of individual populations can be assessed by developing simple arithmetic models of each population. In these models, total numbers and the numbers of males, females, fawns, and individuals in various age classes must be consistent with each other and between successive seasons and years. In general, consistency between successive estimates and models would tend to indicate accuracy; inconsistency would indicate need for refinement of population estimates or recruitment/mortality estimates. All of this may be even more effectively accomplished using a computer-based modeling system such as POSIM (Mooney and Lonner 1978).

We suggest that "habitat" inventories and analyses should begin with general assessments of the structure of individual habitats or "herd ranges" and major environmental characteristics that determine the manner and extent to which each can be used by deer. They should encompass the total area outlined by the yearlong distribution of each population as determined and mapped from distribution-movements data.

Major topographic, vegetative and land-use characteristics and patterns can be broadly inventoried using combinations of topographic relief maps, aerial photographs, LANDSAT photos, and orthophoto quads now available for some areas. These data, together with information on general climatic characteristics and public access should be mapped as overlays and evaluated in relation to distribution and movement patterns. More detailed inventories and analyses of specific environmental features and land uses or management practices can follow as deer-habitat relationships become evident or management needs dictate.

Basic deer management strategy must include continued assessment and evaluation of population and habitat characteristics and changes over time. Population characteristics should be assessed annually in all important or representative habitats, and less frequently in all other habitats. Environmental characteristics and changes should be monitored at least periodically in all habitats.

Population assessment should include trends in population size and structure, fawn production-recruitment, and adult mortality. Continued assessment of sex and age structure may be particularly valuable. These data provide an on-going record of past recruitment and mortality. They can also provide insight to future population trends and compositional changes. Thus, they may be used to evaluate the effects of past events affecting numbers and dynamics of deer and/or to estimate the possible effects of future events and management actions, including hunting regulations and pressures, on a population. Periodic inventory or reassessment of distributional patterns and characteristics should also be considered, especially on important ranges and where significant population or habitat changes have occurred.

Environmental inventory and monitoring needs may vary between individual habitats and populations. Because total deer numbers in any given area are a product of both the total amount of area they occupy and the "quality" of that area in terms of the number supported or produced per unit area, any environmental change that influences the amount of space available or essential characteristics of that space will be important.

Retroactive assessment of vegetational and land use/management changes through the habitat inventories outlined above may be used to evaluate current status. It may also provide insight as to the nature and extent or possible impacts of future vegetation and land use/management changes on the amount and "quality" of available habitat. Continued monitoring of vegetational, land use and land management practices through constant reconnaisance and periodic (3-5 year) inventories would seem to be essential to detect and respond to any potentially significant changes. In light of our findings to date, we cannot recommend any specific means of measuring vegetative composition, forage production and utilization on winter or other seasonally used range areas as a general management practice.

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